ENGINEERING NEWS

A JOURNAL OF CIVIL, MECHANICAL, MINING AND ELECTRICAL ENGINEERING

Vol. LX. No. 15. 220 Broadway, New York, October 8, 1908.

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A TRAVELER FOR VIADUCT ERECTION.

By L. L. JEWEL,* Assoc. M. Am. Soc. C. E.

A steel traveler of rather unusual size and type, designed primarily for the erection of heavy single track viaducts, and operated entirely by electricity, is being used by the McClintic-Marshall Construction Co.

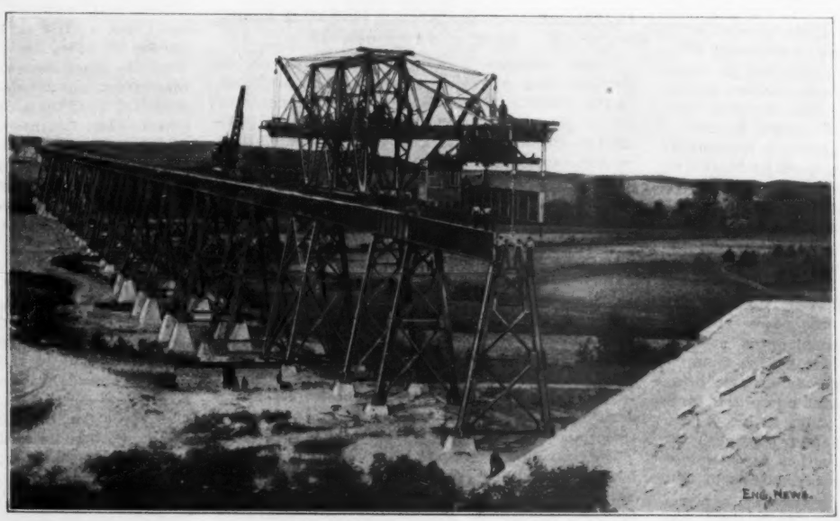
A brief description of the work for which the traveler was originally planned will perhaps be appropriate. Among the bridges furnished and erected by this company on the Virginia Ry. are eleven single-track viaducts, varying in height from 50 to 150 ft., and aggregating approximately 12,000 lin. ft. of structure. With two exceptions, which contain one and six riveted deck trusses, respectively, all the work is deck plate-girder construction and practically all of it is the ordinary 60-ft. spans with 30-ft. towers. One 90-ft. span with 28-ton girders was encountered, the erection of which is shown in an accompanying half-tone. The loading used in the design was Cooper's E-60 giving about 13-ton girders for the 60-ft. spans. The total tonnage involved was about 10,000 tons.

The work as a whole was divided into two groups, a considerable distance apart, but covering little ground individually. The material for each group was shipped and stored at a convenient storage yard and from there run to the various bridge sites as track laying progressed and the bridges were needed. As it was new construction there was no traffic to interfere with the erection operations.

In general the traveler is a steel tower carrying long trussed cantilever arms both front and rear. The bottom chords of these cantilever arms are arranged to carry a crane runway on which may be operated one or more traveling cranes. The general appearance is well shown by the accompanying drawing and half-tone. The tower is 40 ft. high by 60 ft. long and is 9 ft. wide, c. to c. of columns. This width enables the traveler track to be laid on an ordinary floor deck and at the same time will allow material trucks to pass through, running on a standard gage track.

The front cantilever arm projects 100 ft. from the tower and the rear arm extends backward 60 ft., giving a total length of 220 ft. to the traveler. The distance from top of track rail to top of crane rail is 18 ft. 6 ins. This height will allow ordinary cars loaded with bridge material to be run under the rear arm and the steel handled with the cranes from car to final position. The total weight of the traveler and equipment is about 100 tons.

The sills are made up of two 15-in. channels, placed back to back and laced together top and bottom. Eight extra heavy double flanged cast-iron wheels carry the traveler. These wheels are mounted in cast-iron journals with babbited bearings, two being placed tandem on 4-ft. centers under each of the four corner posts, giving a wheel base of 64 ft. to the tower.



15-TON TRAVELER WORKING ON VIADUCT ON THE VIRGINIAN RAILWAY.

The columns of the front bent are of box section, made of two 10-in. channels laced together on the inner face and with a 15 × ½-in. cover plate on the outer face. The columns of the rear and intermediate bents are of two 10-in. channels laced together. The corner columns are framed into the sills with plate and angle brackets about 5 ft. long in order to guarantee an equal distribution of the load over the two wheels at each of these points. A shelf is also built onto the outer face of the corner columns arranged to carry an ordinary "Chicago" boom seat and 12 × 12-in. × 40-ft. timber booms are rigged on the front bent. These booms are used to steady the traveler while moving and to guy it when handling extra heavy loads. In ordinary service, however, such guying has been proven unnecessary. They may also be used to handle loads, working on one side while the opposite boom is used to guy.

The bents of the tower are braced transversely for their top half, with struts made of four light angles laced together and 2-in. diameter diagonal rods. The rods are used in two lengths, giving a slope of about 45°. The bottom half of the bents, below the crane runway, is left entirely clear to allow the free passage of cranes and material. Transverse stiffness is secured by trussing all six vertical columns on their outside faces so as to give a depth of about 5 ft. at their middle.

All longitudinal diagonals in the tower are rods of varying sizes, depending on their position, the heaviest being the tie from the top of the front cantilever arm which is a pair of 2⅝-in. square rods. To provide for torsion due to eccentric loads on the front arm, two additional 2½-in. square rods are passed from side to side of the traveler in this same plane. The longitudinal struts at the top of the tower are made of two 9-in. channels placed back to back and laced top and bottom. This top plane of the tower is divided into four panels by latticed angle struts and braced laterally with 1¼-in. dia. rods.

The crane girders are 2 ft. 4 ins. deep, back to back of angles. They are connected to the inner faces of the tower columns and are extended front and rear as the bottom chord of the cantilever arms. The bottom flange angle on the inner side is inverted to form a shelf and carries a 50-lb. rail for the crane carriages. The gage is 7 ft. 4½ ins. A system of stiff lateral bracing is used continuously from end to end of the traveler between the top flanges of these crane girders.

The struts of this system are made of two light channels resting on top of the crane girders and extending about 2 ft. over the girders at each side. From the ends of these struts, angle knee braces extend down to the bottom flange of the girders to hold the crane runway to true gage. These struts also serve as floor beams for carrying a timber deck in tower and walkways over the arms.

All tension members of the cantilever arms are ordinary rods and eyebars. The inclined posts are made of two light channels placed back to back and laced on both sides. No diagonal bracing is used in the top chords, but the panel points are connected with a transverse strut made of two light channels laced together. In actual practice, this, with the continuous bracing in the plane of the bottom chords, has proved ample to give the desired rigidity to these arms.

The crane in the front cantilever arm is of 15

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tons capacity and travels the full length of this arm. The crane bridge is suspended from the carriage proper and lengthened to give a transverse trolley travel of 14 ft., which is sufficient to take care of any curve ordinarily encountered on heavy viaduct work. The traveler is designed for the maximum load of 15 tons in the extreme position, a counterweight of 17 tons being required on the rear arm. One or more traveling hoists or cranes of short transverse travel may be used through the tower and over the rear arm.

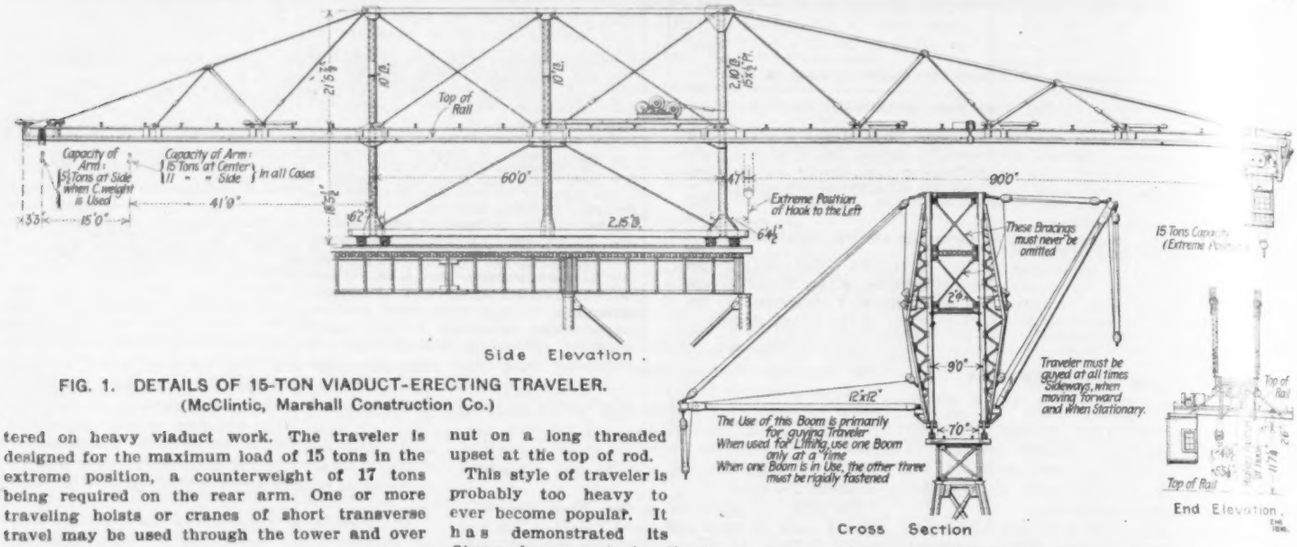

Capacity of Arm: 5 Tons at Side when Counterweight is Used
Capacity of Arm: 15 Tons at Center 11 " " Side } In all Cases
41'0"
15'0"
Top of Rail
60'0"
90'0"
Extreme Position of Hook to the Left
These Bracings must never be omitted
Traveler must be guyed at all times Sideways, when moving Forward and When Stationary.
12"x12"
The Use of this Boom is primarily for guying Traveler When used for Lifting use one Boom only at a Time When one Boom is in Use, the other three must be rigidly fastened
Side Elevation.
Cross Section
End Elevation.

FIG. 1. DETAILS OF 15-TON VIADUCT-ERECTING TRAVELER.
(McClintic, Marshall Construction Co.)

A double drum electric hoisting engine with four independent winch heads is installed on the deck of the traveler. It is used to pull the traveler ahead and to handle the booms on the side. Runner lines from the engine passing through blocks hung from the cantilever arms are also used for assembling bents on the ground when desirable and for filling in the longitudinal bracing of the towers. Holes are provided at intervals all along the top flanges of the crane girders by means of which timbers for carrying such runner lines may be bolted whenever desired.

The power for engine and cranes is supplied by a portable plant mounted in a specially built steel box car. A 50-KW. direct connected generator is driven by a 60-HP. vertical engine. The feed wires which are wound upon an ordinary reel, lead to a spool on the rear of the traveler and are simply reeled out as required by the traveler moving over the bridge. A small steam driven feed water pump and a 300-gal. storage tank completes the equipment for the power plant.

A separate compressed air plant is used in connection with the traveler. It is also mounted in a box car and is entirely independent, being equipped with boiler, feed water pump and tank, air compressor and receiver. This makes it possible to move ahead to the next bridge with the traveler as soon as the erection is complete, without waiting until all riveting, boring of ties, etc., is completed.

In the first bridge erected a 90-ft. span was erected without difficulty, by the use of both cranes as shown in the accompanying half-tone. The material for the forward bent was run out and lowered to the ground underneath the front arm. The bent was assembled complete so it could be "tripped" up to its correct position where it was held by runners from the engine on the traveler deck. The girders were then handled with the front crane and a 10-ton hoist, the former carrying 18 tons of the load.

The best record made by the traveler to date was on the Terrysville viaduct of the Virginian Ry., near Tola, Va. The viaduct is 1,140 ft. long and about 60 ft. high over a good part of the length. It contains 928 tons and was erected in 12½ working days of eight hours, an average of 91.2 lin. ft. per day. This included placing the permanent deck, except guard rails and final bolting down. The rails for traveler were laid flat on the permanent cross-ties without a continuous longitudinal support. Four I-beams were always used, however, under each front wheel in addition to the regular crossties. The traveler was always anchored at all four corners of the tower when in use, by 1¾-in. square rods with several links and hooks at their ends. These were dropped down from the traveler sills and hooked under the inside lower edges of the main girders. They were adjusted simply by a nut on a long threaded upset at the top of rod.

This style of traveler is probably too heavy to ever become popular. It has demonstrated its fitness, however, to handle the work for which it was designed, quickly and economically, and where the magnitude of the work in view would justify the first cost, the type is worth consideration.

PROPOSED RESERVOIR SYSTEM IN OHIO RIVER BASIN.*

By H. C. NEWCOMER.†

These remarks may well be introduced by quoting from a French engineer, Mr. A. Troté, of the Ponts et Chaussées. In a paper prepared for the Eleventh International Congress of Navigation, meeting at St. Petersburg in July, 1908, on the subject of "Protection of low-lying lands against invasion by water," he says of reservoirs:

> This system seems very seductive at first glance, but its application raises serious difficulties.

He regards reservoirs, indeed, as being generally impracticable for such use, except in so far as incidental benefit may be derived from their occasional construction for municipal and industrial purposes. Similar views are given in a most interesting discussion of the question by Major Chittenden, in his paper on "Reservoir Sites in Wyoming and Colorado," published in 1898 and referred to by Mr. Leighton. Everyone desiring to investigate the subject should read this paper.

The attractive features and undoubtedly real benefits attending the use of reservoirs have naturally aroused the attention of engineers on frequent occasions, and will doubtless always appeal to the popular imagination, as well as to the various interests that expect to derive benefit therefrom at the public expense. It may even be true, as indicated by Mr. Mitchell, of the Geological Survey, in the "Review of Reviews" for May, 1908, that a majority of the members of the former Inland Waterways Commission were in favor of the reservoir system of improving our navigable rivers. This, however, would be subject to the observation that the commission had only one river engineer among its members. It had equal representation from the Reclamation Service, the Forest Service, the Bureau of Soils, and the Bureau of Corporations. Everyone will surely admit the very able and distinguished service rendered in their respective fields of action by these bureaus, as well as by the Geological Survey, but it appears somewhat natural reflection that none of these would ordinarily be regarded as an eminent source of authority on navigation problems, for the simple reason that they have not been accustomed to dealing with such matters.

In discussing Mr. Leighton's most interesting paper, it may be well to dwell a moment on his declaration of fundamental principles that should govern the improvement of navigation. These may appear plausible enough at first sight, but a little consideration tends to the conclusion that they are *a priori* in character, evolved from his inner consciousness, so to speak, rather than from an extensive acquaintance with the practical conditions that confront the river engineer. Mr. Leighton admits, for instance, that complete control of a river by reservoirs is probably impracticable. This naturally raises the question as to the degree of control that is necessary for navigation purposes. Of course, if navigation is to help bear the burden of numerous other problems, such as flood protection, water pollution, water supply for municipal and industrial purposes, power development, forest preservation, and so on, the extent of this control may be considerably enlarged. On the other hand, deliberate examination of these various problems may lead to the conclusion that each can be best solved by more or less direct treatment adapted to its special ends, and that the control over river flow that can reasonably be supplied for navigation interests is of a different character from that suggested by Mr. Leighton. He admits, indeed, that locks and dams will be required anyhow on the Ohio River. In fact, he recently stated before the Flood Commission of the Pittsburg Chamber of Commerce that there need be no conflict between the reservoir and canalization plans, and that canalization will undoubtedly be necessary to secure the desired depth of 9 ft. Furthermore, he said that if the situation should arise where only a limited sum of money could be applied to the improvement of navigation, requiring a choice between the canalization and reservoir work, that river interests would do wisely to choose canalization. In other words, this is necessary, while reservoirs would only furnish valuable assistance, so far as navigation is concerned. But this seems to very largely surrender his position that reservoirs occupy a place of commanding importance in any logical or well-considered plan for the improvement of navigation.

The mere fact that river improvement works have been under consideration for many years, both here and in Europe, and in no case have entirely artificial reservoirs on an extensive scale been adopted in the interests of navigation, would lead one to infer that such a system is generally impracticable. It is true that Messrs. Leighton

[*On the recent paper by Mr. M. O. Leighton, Assoc. M. Am. Soc. C. E., Chief Hydrographer U. S. Geological Survey. The paper was submitted by Mr. Leighton to the Inland Waterways Commission, and was abstracted at length in our issue of May 7, 1908. In our issue of June 11, 1908, there appeared an extended, adversely critical discussion of the paper by Capt. W. D. Connor, Corps of Engineers, and an answer thereto by Mr. Leighton; also a favorable discussion by Mr. A. H. Horton, Assoc. M. Am. Soc. C. E.—Ed.]

†Major, Corps of Engineers, U. S. Army, Pittsburg, Pa.

TABLE SHOWING DAILY RAINFALL, IN INCHES, MARCH 10 TO 14, 1907, INCLUSIVE, AT 16 U. S. AND 35 STATE WEATHER BUREAU STATIONS, INDICATED ON MAP BY ITALIC NUMERALS WITHIN CIRCLES.

(Corresponding numerals, together with names of station, used here also.)

No.	Name.	March, 1907— 10.	11.	12.	13.	14.
1.	Warren, Pa.	.04	.16	.01	.12	.70
2.	St. Mary's, Pa.	.50	.0	...	.35	...
3.	Saegertown, Pa.	.13	.0	.12	.27	.25
4.	Franklin, Pa.	.18	.04	.10	.34	.46
5.	Clarion, Pa.	.26	.02	.04	.62	.54
6.	Parker's Landing, Pa.	.3	.12	.04	.80	.74
7.	Freeport, Pa.	.26	.15	.64	1.85	.92
8.	Springdale, Pa.	.18	.15	.24	1.57	1.00
9.	Davis Isl. Dam.	.14	.14	.10	1.40	.97
10.	Pittsburg, Pa.	.12	.14	.06	1.52	.86
11.	Cassandra, Pa.	.60	.30	...	2.00	1.25
12.	Johnstown, Pa.	.04	.64	.01	1.24	1.44
13.	Derry, Pa.	.47	.00	.10	1.49	1.41
14.	Indiana, Pa.	.40	.00	.50	1.30	1.25
15.	Saltsburg, Pa.	.16	.28	.04	1.28	.94
16.	Somerset, Pa.	.00	.00	.20	1.58	...
17.	Grantsville, Pa.	.80	.00	.05	2.50	.95
18.	Confluence, Pa.	.28	.44	...	1.35	1.80
19.	Deer Park, Md.	.40	.0	.0	2.60	.45
20.	Oakland, W. Va.	.0	.0	.04	1.00	.50
21.	Terra Alta, W. Va.	1.30	.0	.22	1.84	.95
22.	Rowlesburg, W. Va.	.24	.70	.04	1.46	1.12
23.	Parsons, W. Va.	.0	.0	.0	2.5	.5
24.	Elkins, W. Va.	1.20	.0	.42	.32	.44
25.	Pickens, W. Va.	1.34	.0	.95	.90	.45
26.	Philippi, W. Va.	.72	...	.24	1.40	.71
27.	Weston, W. Va.	.46	.52	.00	.58	1.12
28.	Lost Creek, W. Va.	.78	.0	.52	1.04	.38
29.	Grafton, W. Va.	.79	.0	.33	1.40	.80
30.	Fairmont, W. Va.	.38	.18	.06	1.86	1.22
31.	Mannington, W. Va.	.45	...	.26	1.41	1.17
32.	Morgantown, W. Va.	.30	.0	.15	1.70	1.40
33.	Greensboro, Pa.	.20	.40	.08	1.34	1.90
34.	Uniontown, Pa.	.57	.0	.20	2.20	1.34
35.	California, Pa.	.50	.03	.13	1.81	1.46
36.	Dam No. 4, Pa.	.18	.33	.40	1.40	2.20
37.	W. Newtown, Pa.	.16	.20	.20	1.00	1.84
38.	Irwin, Pa.	.50	.0	.08	1.47	1.62
39.	Greenville, Pa.	.40	.0	.17	.45	.36
40.	Grove City, Pa.	.09	.0	.11	.53	.41
41.	Ellwood Jc., Pa.	.12	.18	.12	1.36	.74
42.	N. Cumberland, W. Va.	.15	.0	.10	.85	.75
43.	*Wellsburg, W. Va.	.40	.0	.25	2.00	1.25
44.	*Wheeling, W. Va.	.16	.04	.04	1.00	1.20
45.	Claysville, Pa.	.45	.0	.10	1.70	2.00
46.	Moundsville, W. Va.	.50	.0	.08	2.28	2.52
47.	Aleppo, Pa.	.50	...	.23	2.40	1.85
48.	*N. Martinsville, W. Va.	.55	.0	.32	2.61	2.45
49.	Smithfield, W. Va.	.54	.12	.52	1.20	1.35
50.	*Glenville, W. Va.	.95	...	.60	.10	1.05
51.	Sutton, W. Va.	.70	.0	.85	1.10	.10

*Indicates stations just outside of left margin of map.

and Horton, in their paper on "The Relation of the Southern Appalachian Mountains to Inland Water Navigation," state that this method of channel improvement has been extensively used in Russia and France, but I can find no warrant for this assertion beyond the reservoir system at the headwaters of the Volga River, where a region of many natural lakes has been adapted to reservoir purposes in a similar manner, but on a smaller scale, than at the headwaters of the Mississippi. It appears, also, that reservoirs have been proposed, but not built, for increasing the low-water discharge of the Oder in Germany and of the Loire in France.

In this same paper, speaking of the Monongahela River, Messrs. Leighton and Horton say:

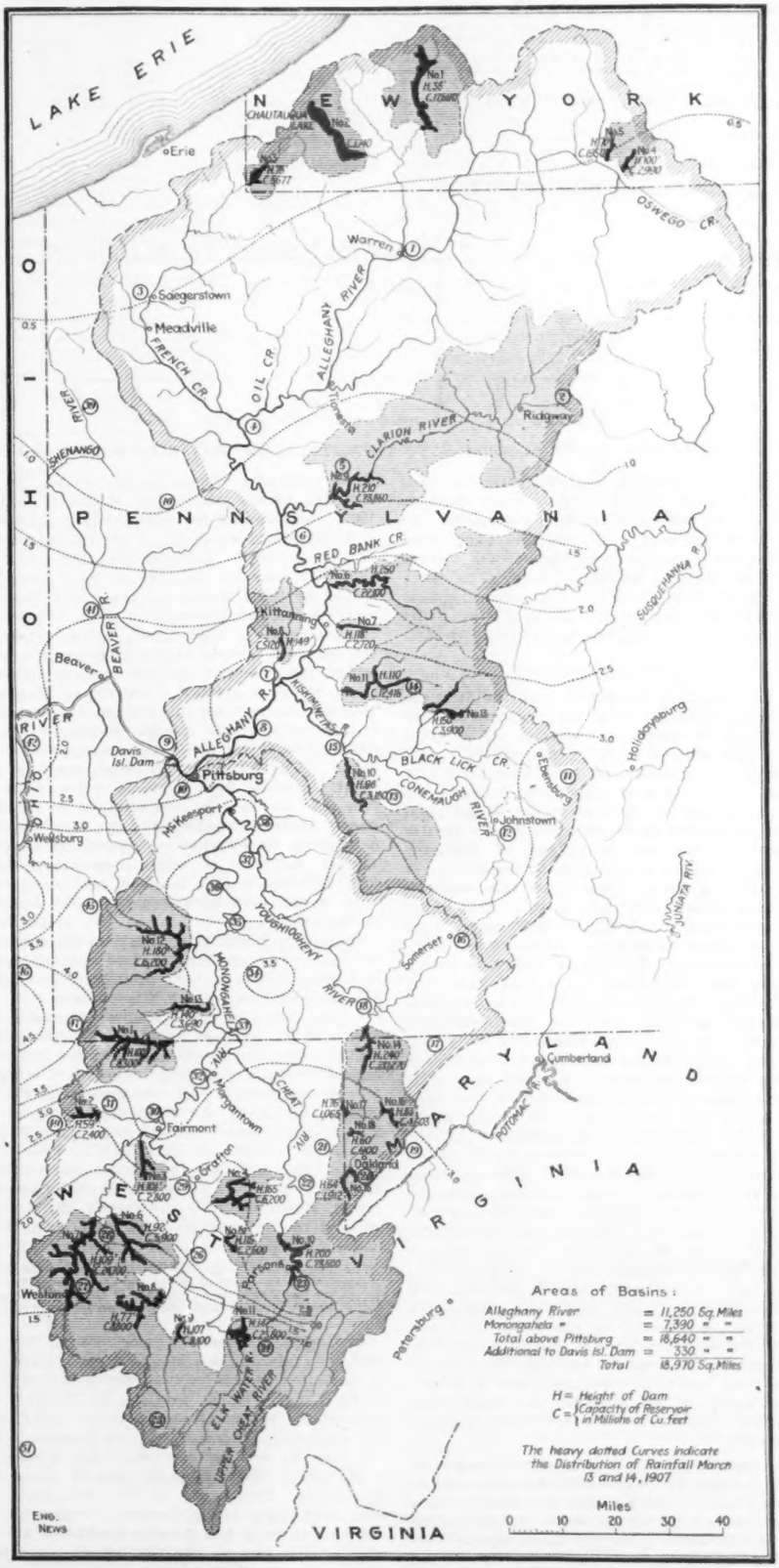
> The Monongahela system of locks and dams was constructed, so far as public records show, without any suitable investigation of the possibilities of maintaining navigable stage in the river by conservation of flood waters. The idea that it might be possible to maintain navigable stage during low-water seasons by saving some of the water wasted during spring floods appears not to have been considered. The dams were constructed in the face of the knowledge that maintenance charges would be heavy and would continue generation after generation. The fact that they might be used for power development if sufficient summer flow were provided and so become self-supporting seems not to have made a strong impression. If this possibility had been taken into account it would not have been necessary to construct as many locks and dams as now exist along the river. The entire system up to Morgantown might have been abolished, as can be shown by information at hand.

And again, speaking of the Youghiogheny:

> There is presented here a condition identical with that on the Monongahela before canalization, but here there is the added advantage that the proposed Youghiogheny system is a new one and no mistake need be made.

It is possible that these gentlemen may already be inclined to modify these statements. In any case it is certain that fuller knowledge of the conditions would make them hesitate to discredit the work done on the Monongahela River.

There are numerous disadvantages connected with the reservoir plan that might be discussed at length, such as the probable lack of *available* reservoir sites sufficiently distributed, the permanent withdrawal from other uses of large areas of bottom land of exceptional fertility, the disastrous results of possible failure of dams, the unsanitary conditions attending large fluctuations of water level in reservoirs, the disorganization



(At weather-bureau station 29 the capacity (C) of reservoir No. 16 should read: 4,912 instead of 1,912.)

FIG. 1. DRAINAGE AREAS OF THE ALLEGHENY AND MONONGAHELA RIVERS, SHOWING PORTIONS UNDER PARTIAL OR COMPLETE FLOOD CONTROL BY PROPOSED RESERVOIR SYSTEM.

(Prepared under the direction of Major H. C. Newcomer, Corps of Engineers, U. S. A. Authorities: Official Post Route maps, U. S. P. O. Dept.; Official R. R. map, Pa. Dept. Internal Affairs. The reservoir sites located by Mr. M. O. Leighton are shown solid black and their tributary drainage areas by horizontally ruled areas. The serial numbers in Mr. Leighton's list are given near the respective dams. Italic numerals within circles indicate the 16 U. S. and 35 State weather bureau stations for which rainfall records for March 10 to 14, 1907, inclusive, are shown in tabulated form alongside.

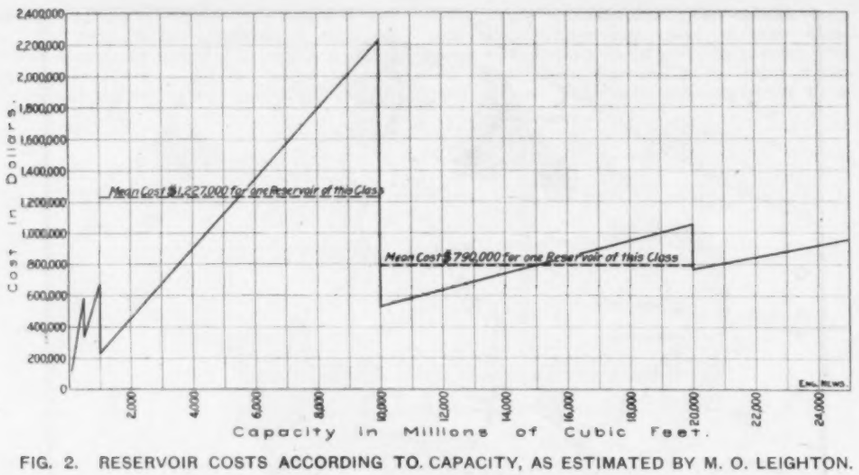


FIG. 2. RESERVOIR COSTS ACCORDING TO CAPACITY, AS ESTIMATED BY M. O. LEIGHTON.

of public road systems and obstruction of local communications, the conflict between methods of control for flood prevention and industrial and navigation purposes, the inevitable impairment of reservoir capacity by sedimentation, and so on. Such features would all have to be taken into consideration, of course, in passing judgment on the system as a whole. Some of them would doubtless assume proportions of grave importance.

FLOOD PROTECTION.

It can doubtless be shown, also, that the advantages connected with the proposed system are neither so certain in character nor so great in value as claimed by Mr. Leighton.

Taking the question of flood prevention, for instance, there is good reason for doubting his assumption that the flood discharge at any point would be lessened in the same or even a greater proportion than the percentage of tributary drainage area that is controlled by reservoirs. It is obvious, of course, that where this drainage area is of great extent and most of it is under no control whatever, it is possible to have a flood from the uncontrolled area. Great storms, however, are generally widespread and it is hardly probable that any would occur that would not involve some of the reservoirs; still it is almost invariably the case that the flood-producing storm is not uniformly distributed over the drainage area. It may be concentrated mainly on the unprotected region, in which case it is obvious that the proportion of runoff held back will be less than that assumed by Mr. Leighton. This is well illustrated by the conditions that obtained during the flood of January, 1907, on the Ohio River. This flood attained exceptional magnitude at Cincinnati but barely passed the danger line at Pittsburg, Wheeling and Parkersburg. Moreover, it reached its highest stage at all these places at nearly the same time, thus indicating a practically simultaneous arrival of storm discharge from various portions of the drainage area at corresponding points along the river, with only a moderate runoff on the upper river and one of extraordinary amount at Cincinnati. The upper river in this case did not contribute largely to the flood height at Cincinnati, and it is evidently wrong to assume that the upper river reservoirs would have very materially assisted in reducing it.

The character of the flood-producing storms in the Ohio basin further emphasizes this consideration of the relative inefficiency of reservoirs at the headwaters of the river for controlling floods on its lower reaches. These storms, fortunately, all sweep over the basin from the southwest so that rainfall on the lower river has some time to run off before its discharge is augmented by that from above.

PITTSBURG FLOOD OF 1907.

The accompanying map, Fig. 1, shows the drainage areas of the Allegheny and Monongahela rivers, the shaded areas indicating the portions under complete or partial control by the proposed reservoirs. There is also shown the distribution of the rainfall of March 13 and 14, 1907, which caused the unprecedented flood stage at Pittsburg on March 15. A careful examination of the conditions indicates that the portion of this total rainfall that would have been controlled by the reservoirs is practically the same as the proportion of controlled area. It is worthy of note, however, that a part of this rainfall on the southern portion of the Monongahela basin, where the reservoir control is most complete, could not have reached Pittsburg on March 15. Making allowance for this feature, the proportion of control over the rainfall producing the extreme flood stage would be correspondingly reduced. The comparatively local origin of this great Pittsburg flood stage is indicated by the fact that the flood heights attained on the Allegheny above Springdale and on the Monongahela above Brownsville were considerably under former records. It seems reasonable, therefore, to conclude that the flood control at Pittsburg would have been less than Mr. Leighton estimates.

Foreign professional opinion does not appear to favor reservoir systems for flood control, though individual reservoirs have been built, and others are projected, partly for this purpose.

In the "Annales des Ponts et Chaussées" for 1881, Vol. II., appears an article by Mr. L. Gros on the "Insufficiency of Reservoirs for Diminishing the Danger of Floods," written in response to renewed agitation of the subject in France. He reviews briefly the grounds upon which the French government rejected this plan of flood protection. Again, in Vol. LXVII., Proc. Inst. C. E., 1882, there are two papers on "Conservancy of Rivers" in England. In the discussion Mr. E. Malézieux gives the French official views opposed to the reservoir plan. Also, Mr. H. de Lagréné says:

> The authors were right in rejecting large impounding reservoirs, as in order to be of use they would have to be placed low down in valleys where the land was generally most valuable and their construction would be costly.

The fifth question for consideration by the Eleventh International Congress of Navigation, as indicated above, is the "Protection of Low Lying Lands Against Invasion by Water." In none of the papers presented, that I have seen, are reservoirs advocated for this purpose.

It may be well in this connection to mention a feature of flood damages that is sometimes overlooked. The banks of the Ohio have for ages been subject to overflow. Occupation of the riparian lands has developed with full knowledge of this fact on the part of all concerned. Property exposed to damage has been deliberately placed there, and the acceptance of this risk has doubtless in many cases been fully justified. If flood damages amount to the enormous sums stated, protection of this property would correspondingly increase its value. The question arises whether the national treasury is properly chargeable with the cost of furnishing the protection.

POWER DEVELOPM[illegible]

Again, it is doubtless true that [illegible] is a great future for water-power develop[illegible] but it is not clear how the general gover[illegible] can derive any such revenue from this [illegible] as Mr. Leighton estimates. The type [illegible] expressions used in current discussions, such [illegible] indicated horsepower" of various rivers, "p[illegible] developed by reservoirs and Government da[illegible] may convey a wrong impression to the po[illegible] mind, as indicating something ready for [illegible] power customers, especially as the estimat[illegible] its value approximates to the rate at which [illegible] is being actually delivered on a 10-h[illegible] basis by comparatively small power instal[illegible]ons. Of course, it is obvious to the engineer that power plants, transmission lines, etc., are necessary to make the so-called power available. In the proposed system it is not expected to develop power at the reservoir sites, on account of the extreme fluctuations in head of water, and so there would simply be the flow of the streams, more or less regulated, for which a charge would be made in the general case. Now it is a question to whom this flow belongs. It certainly does not belong to the general Government, whose authority in this respect is limited to the exercise of such control as is required in the interests of navigation. In all navigable rivers the beds of the streams belong to the respective States and it would seem that the ownership of the flow of water should be found in the same quarter, though riparian proprietors will doubtless claim the right to its free use. On this theory the State should be entitled to make an annual charge for the flow and this should be one of the conditions to be imposed in all cases where it grants a charter for power development, though I am not aware of any instance in the United States where this has ever been done. This charge should, of course, be subject to periodical revision to meet the changing conditions of industrial development.

Water-power leases have been issued by the Province of Ontario, with rentals varying from 25 cts. to $1 per HP. per annum, based on the quantity of power developed. The highest rate applies only to powers in the vicinity of an active market for energy. These are very different figures from the $20 rate used by Mr Leighton. Of course, it is impossible to determine such a matter in advance, but it would at least seem very rash as a financial proposition to count on more than $5 per HP. as an annual rental charge for the stream flow. This position might be further supported by references to existing conditions of power development, but it will probably be conceded by engineers familiar with such matters.

COST OF RESERVOIR SYSTEM.

Notwithstanding all these considerations, however, that tend to lessen the estimates of value of benefits to be derived from the system, there can be no question that there are such benefits of great importance, and the system should be built if it can be done at a reasonable cost. This is the vital feature of the problem and the one that generally condemns the system as being impracticable from a financial standpoint. It is proposed, therefore, to give some consideration to Mr. Leighton's estimate of cost. It is proper to observe that Mr. Leighton himself does not regard this estimate as very reliable. The main purpose of his paper was to develop other possibilities of the system. It is believed, however, that a little more extended consideration of this very important branch of the subject would have convinced him that his treatment of it is not sound, and would have modified his opinion that it affords a fairly reasonable indication of the probable cost.

Table I. gives a summary of all the reservoirs in the Ohio basin, listed by Mr. Leighton, classified according to capacity, with estimates of cost by his scale. Several equivalents of the unit costs used by him are given for the convenience of those who are not accustomed to use the unit of a cubic foot per second per year. It will be observed that this table includes three more reservoirs than Mr. Leighton's summary, and gives a somewhat greater total cost.

TABLE I.—SUMMARY OF PROPOSED RESERVOIR SYSTEM.

Nos.	Capacities, millions of cu. ft.	Aggregate capacity of class.	Per cent. of total capacity.	Unit costs. No. of reservoirs derived from.	Unit costs. Per cu. ft. per sec. per year.	Unit costs. Per acre ft.	Unit costs. Per million Cu. ft.	Total cost.
1.....	100- 500	420	0.02	21	$36,495	$50.30	$1,157.00	$485,940
2.....	500- 1,000	900	0.04	12	20,775	28.70	658.00	592,200
3.....	1,000-10,000	243,162	11.3	35	7,047	9.73	223.00	54,225,126
4.....	10,000-20,000	240,795	11.2	8	1,664	2.30	52.80	12,713,976
5.....	over 20,000	1,663,472	77.4	3	1,210	1.67	38.30	63,710,977
		2,148,749					$61.30	$131,728,219

Fig. 2 represents graphically the scale of costs. It gives the entire cost for individual reservoirs, according to capacity. Attention is invited to the higher mean total cost of reservoir for those of 1,000 to 10,000 capacity as compared with those of far greater capacity, ranging from 10,000 to 20,000 million cu. ft. While it is true that, other things being equal, the *unit* cost will be less for the greater capacity, this startling result of less *total* cost for the greater capacity indicates something radically wrong.

Table II. gives information concerning proposed reservoirs in the Allegheny basin and Table III. concerning those in the Monongahela basin, including the individual estimates of cost and other data given by Mr. Leighton. An examination of these tables will disclose some peculiar results, such as that already noted in connection with Fig. 1. For instance, No. 10 on the Monongahela with a dam about twice as high, and covering 50 per cent. more ground, costs about half as much as No. 9.

Referring to Table I. it will be noted that 88% of the total capacity of the entire system is found in the reservoirs containing more than 10,000 million cu. ft., and 77% of the total in those of more than 20,000 million cu. ft. As the unit costs seemed extremely low for these larger works, information was sought concerning the reservoirs that were considered in determining them. Mr. Leighton very kindly furnished the list of them, which is given in Table IV., with some data concerning them.

It will be noted that there are only nine instead of eleven as indicated in Mr. Leighton's table, the Manachee Meadows and Little Colorado reservoirs having been duplicated through some oversight, thus reducing somewhat the resulting unit cost that he obtained for reservoirs between 10,000 and 20,000 million cu. ft. It will be noted, also, that only one has been built and two others are under construction.

It would seem that a most casual inspection of this table is sufficient to convince anyone that these reservoirs, mainly located in the arid regions of the West, do not afford a fair criterion for estimating costs of reserviors in the Ohio River basin. The Upper Mississippi River System, developed from large natural lakes in a region sparsely settled at the time, is obviously not a comparable case. Yet, as indicated above, these reservoirs were used as a standard for computing the cost of fully 88% of the total capacity of the proposed system.

It was considered desirable to test Mr. Leighton's estimate by a brief investigation of the conditions that obtain at some of his proposed reservoir sites, and accordingly those were selected in the Monongahela basin that have capacities of over 10,000 million cu. ft. There are six of these, comprising one-third of the total number and containing over two-thirds of the total reservoir capacity. Referring to Table III., it will be seen that they are Nos. 7, 8, 10, 11, 12 and 14, located respectively on the West Fork River, Buckhannon River, Cheat River, Tygart River, Ten-Mile Creek and Youghiogheny River.

Captain E. M. Adams, Corps of Engineers, has visited all these sites and has made a report from which the following quotations are derived:

In order to judge of the accuracy of Mr. Leighton's estimate of the cost of the above reservoirs, I have visited each site, and have collected such data as are, in the absence of detailed survey, available.

As to the proposed dams: In general it may be said that the sites selected by Mr. Leighton appear to be favorable for the construction of dams. None, however, of these open valleys present the uniquely favorable conditions which are found at certain sites indicated by Mr. Leighton as criterions of cost.

At all sites herein discussed, rock foundation and abutments appear to be within reach; whether rock is actually within reach, and whether it is of character to withstand the strains to which it will be subjected by Mr. Leighton's dams, can be ascertained by detailed and thorough examination.

In view of the enormous industrial interests which will be menaced by the construction of the proposed reservoirs, it is unlikely that the inhabitants of Western Pennsylvania will permit any form of construction less permanent and secure than that provided by masonry dams of approved type.

In estimating the cost of the proposed dams, I have therefore assumed that in each case the dam will be of masonry, of gravity section. (Triangular profile designed by Wegmann, Practical Profile No. 1, Trans. Am. Soc., June, 1907.) In the absence of detailed survey, I have assumed that good and sufficient foundation will be found within 25 ft. of the low-water level.

Captain Adams made two estimates for the dams, based on different unit costs for their masonry contents. The estimates given below are obtained by using a rate of $8 per cu. yd. This may at first seem too high a figure, but it should be noted that it is intended to cover all items of construction, such as excavation and the extensive controlling works, with their gates and operating machinery. If any one thinks a different unit cost should be used, he can readily modify the estimate accordingly.

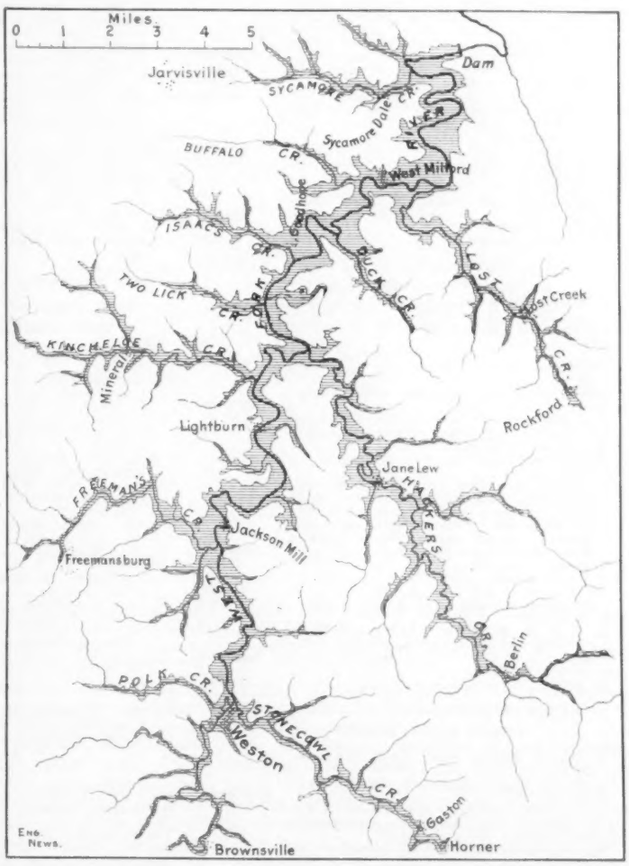


FIG. 3. PROPOSED WEST FORK RESERVOIR, MONONGAHELA BASIN, WEST VIRGINIA.

(Traced from topographical map, U. S. Geological Survey, furnished by M. O. Leighton. Shaded area indicates reservoir.)

As to the incident damages: The significance of this feature in the Monongahela basin is shown by the fact that in certain cases entailed damages will exceed cost of dam.

In estimating damages to towns, I give a fair valuation to improved real estate and to industrial enterprises. In certain localities, notably Weston, Buckhannon, and Elkins, present sales are based upon fictitious values; the values herein assigned are conservatively low. In any case, these values may be expected to increase rather than decrease.

Damages due to inundation of coal deposits and farm lands are estimated upon the basis of present terms of transfer. The value of the coal lands will decrease as areas are mined out; but it may be noted that the construction of a reservoir over an undermined site becomes hazardous and costly, if not impracticable.

Damages due to inundation of railroads and roads are estimated upon the mileage submerged only; but it is probable that the United States would also have to pay

TABLE II.—RESERVOIRS IN ALLEGHENY BASIN.

Order on list	Area of control, sq. mi.	Height of dam ft.	Acres submerged.	Million cu. ft. capacity.	Cost.
1.....	275	38	24,000	17,590	$928,752
2.....	27	..	13,400	1,740	388,020
3.....	86	75	4,700	5,677	1,265,971
4.....	46	100	.....	2,990	666,770
5.....	30	70	.....	1,950	434,850
6.....	370	251	5,300	22,100	846,430
7.....	48	118	1,390	2,720	606,560
8.....	80	149	2,260	5,120	1,141,760
9.....	436	210	6,920	23,850	914,455
10.....	58	98	2,200	3,180	709,140
11.....	200	110	7,800	12,415	655,512
12.....	52	122	1,300	2,860	637,780
13.....	66	150	1,620	3,900	869,700
	1,774		70,890	106,092	$10,065,700

TABLE III.—RESERVOIRS IN MONONGAHELA BASIN.

Order on list	Area of control, sq. mi.	Height of dam ft.	Acres submerged.	Million cu. ft. capacity.	Cost.
1.....	150	100	5,800	8,300	$1,850,900
2.....	40	59	2,100	2,400	535,200
3.....	40	101	1,600	2,800	624,400
4.....	80	155	3,600	6,200	1,382,600
5.....	40	115	1,300	2,600	579,800
6.....	100	92	4,500	5,900	1,315,700
7.....	380	109	15,900	24,700	946,010
8.....	310	77	13,300	18,800	992,640
9.....	140	107	4,300	8,100	1,806,300
10.....	440	200	6,600	28,800	911,540
11.....	330	142	10,000	19,100	1,008,480
12.....	283	180	.....	15,200	802,560
13.....	69	140	.....	3,690	822,870
14.....	255	240	4,220	20,270	776,341
15.....	58	83	3,200	4,603	1,026,469
16.....	62	64	3,930	4,912	1,095,376
17.....	13	70	1,100	1,065	237,495
18.....	11	60	760	900	592,200
	2,801		82,010	173,340	$17,306,881

TABLE IV.—RESERVOIRS OF MORE THAN 10,000 MILLION CUBIC FEET CAPACITY USED BY MR. LEIGHTON AS BASIS OF ESTIMATE OF COST.

Name.	Location.	Dam—Type.	Dam—Height ft.	Dam—Length on top, ft.	Capacity million cu. ft.	Cost per million cu. ft.	Present status.
San Carlos	Arizona	Masonry	142	252	10,500	$117.32	Projected.
Manachee Meadows	California	Rock fill	85	460	10,800	13.95	"
Lower Carson	Nevada	Concrete rubble	110	725	11,760	38.05	Under construction.
White Rock Canyon	New Mexico	Masonry	80	...	13,070	91.96	Projected.
Little Colorado	Arizona	Earth and rock fill	...	...	15,400	22.16	"
Upper Narrows Mojave River.	California	Masonry	...	...	17,000	101.47	"
Salt River	Arizona	Masonry	284	about 680	56,600	50.73	Under construction.
Rio Verde	Arizona	Rock fill	...	...	70,500	57.08	Projected.
Upper Miss. River System...	Minnesota	.....	...	...	93,500	7.35	Built.

the entire cost of relocation, which, at present, is indeterminate.

In the following, each reservoir is considered separately:

WEST FORK RESERVOIR.

Dam:
Estimated length: crest, 1,386 ft.; base, 200 ft.
Estimated height above low water, 115 ft.
Probable cost $1,903,720

The proposed reservoir lies in the West Virginia coal fields. Inhabitants state that the Pittsburg vein lies at a depth of 200 ft. below the river. No operations have been conducted in this vein. The mines now open are operating in an apparently thin vein which lies above the proposed reservoir level. In the absence of definite published information as to geologic conditions it is impossible to state damages to mining interests. But it may be said that bottom land, including mineral rights, is selling at $100 per acre. When mining operations are extended south to Clarksburg, this price may be expected to rise rapidly.

The proposed reservoir will submerge:

(1) Towns:	
Weston, county seat of Lewis Co.; population, 7,000; site of West Virginia Hospital for Insane, cost $1,500,000; County Courthouse; 7 churches; large school; 4 banks; 3 hotels; foundry and machine shops; flour, saw and planing mills; roundhouse and repair shops; glass, brick, and carriage factories; streets paved and lighted by electricity; damages.....	4,500,000
Lost Creek, population, 200; damage.....	15,000
Jane Lew; population, 1,000; damage.....	85,000
West Milford; population, 450; damage.....	30,000
Goodhope, Lightbarn, Gaston, Homer, Berlin, Rockford, etc.; damage, small.	
(2) Farming land:	
9,000 acres at $100	900,000
6,200 acres at $20	124,000
(3) Railroads:	
B. & O. R. R., Richwood branch from Clarksburg; submerged, 22 miles; damage	550,000
(4) Roads; earth:	
104 miles; damage	83,200
Total ascertained damages	$6,287,200

BUCKHANNON RIVER RESERVOIR.

I believe that Mr. Leighton has overstated the capacity of this reservoir. (Area should apparently be about 5,000 acres instead of 13,300.)

Dam:
Estimated length; crest, 475 ft.; base, 90 ft.
Estimated height above low water, 80 ft.
Probable cost $377,088

The proposed reservoir lies outside of the West Virginia coal fields; no damage to mining interests is anticipated.

The proposed reservoir will submerge:

(1) Towns:	
Buckhannon, county seat of Upshur Co.; population, 4,500; court-house; opera house; pressed and window glass factories; woolen, flour and planing mills; tannery; brick yards; West Virginia Wesleyan College; damages	1,550,000
Lorentz; damages	15,000
(2) Farming land:	
4,400 acres at $80	352,000
500 acres at 20	10,000
(3) Railroads:	
B. & O. R. R.; Tygart Valley and Pickens branches; submerged, 15 miles; damages	375,000
(4) Roads; earth:	
30 miles; damage	24,000
Total ascertained damages	$2,326,000

CHEAT RIVER RESERVOIR.

Dam:
Estimated length; crest, 1,900 ft.; base, 250 ft.
Estimated height above low water, 200 ft.
Probable cost $5,634,368

The proposed reservoir lies outside of the West Virginia coal fields; no damages to mining interests are anticipated.

The proposed reservoir will submerge:

(1) Towns:	
Parsons; county seat of Tucker Co.; population, 1,700; court-house; opera house; pulp, planing and grist mills; damages..	550,000
St. George; population, 400; damages	50,000
(2) Farming land:	
5,360 acres at $90	482,400
1,340 acres at 20	26,800
(3) Railroads:	
Western Maryland R. R., main line, from Belington and Elkins to the east; submerged, 5 miles; damages	125,000
(4) Roads; earth:	
Submerged, 23 miles; damage	18,400
Total ascertained damages	$1,052,600

TYGART RIVER RESERVOIR.

Dam:
Estimated length; crest, 1,200 ft.; base, 200 ft.
Estimated height above low water, 145 ft.
Probable cost $2,383,040

The proposed reservoir lies outside of the West Virginia coal fields; no damage to mining interests is anticipated.

The proposed reservoir will submerge:

(1) Towns:	
Elkins; county seat of Randolph Co.; population, 6,500; 2 machine shops; tannery; ice plant; large brewery; schools; opera house; paved streets; 2 hotels; many brick buildings; brick kilns; Western Maryland roundhouse and repair shops; damages..	3,500,000
(2) Farming land:	
3,000 acres at $80	240,000
4,500 acres at 20	90,000
(3) Railroads:	
Main line of Western Maryland R. R. from Belington to the east and branches south toward Beverly; submerged, 9 miles; damages	225,000
(4) Roads; earth:	
16.5 miles; damage	13,200
Total ascertained damages	$4,068,200

TEN-MILE CREEK RESERVOIR.

Dam:
Estimated length; crest, 1,680 ft.; base, 150 ft.
Estimated height above low water, 180 ft.
Probable cost $4,454,744

The proposed reservoir will overlie the coal of the Pittsburg vein in which, in this valley, operations have just begun.

Damages; mineral rights of 6,400 acres at $1,500	9,600,000

The proposed reservoir will submerge:

(1) Towns:	
Clarksville; 600 inhabitants; damages.....	60,000
Zollarsville; 200 inhabitants; damages....	20,000
Bissell; 100 inhabitants; damages insignificant.	
Ten-Mile; 100 inhabitants; damages; insignificant.	
(2) Farming land:	
1,280 acres at $80	102,400
5,120 acres at 10	51,200
(3) Industrial properties:	
At Besco; one coal mine operating in Pittsburg vein; coal washer; 100 coke ovens, new; 2 brick kilns; one fan; one hoisting plant; one natural gas pumping station; damages	200,000
At Zollarsville; one coal mine operating in Pittsburg vein; one coal washer and coke ovens now in course of construction; one hoisting plant; two natural gas pumping stations; damages	120,000
(4) Railroads:	
Spur of P. R. R. running from Millsboro to Besco; submerged, .5 mile; damages..	7,500
Spur of P. R. R. running from Cokeburg to mine near Zollarsville; submerged, 3 miles; damages	45,000
(5) Roads:	
30 miles; the greater part are ordinary earth roads; some are macadam; damages	27,600
(6) Gas wells:	
Value problematic.	
Total ascertained damages	$10,233,700

YOUGHIOGHENY RIVER RESERVOIR.

Dam:
Estimated length; crest, 2,580 ft.; base, 640 ft.
Estimated height above low water, 240 ft.
Probable cost $11,782,784

The proposed reservoir will submerge:

(1) Towns:	
Watsondale; Standard Oil pumping plant; damage	60,000
Selbysport; damage	20,000
Friendsville; damage	100,000
Kendall; large sawmill plant; coal mine not in operation; damage	120,000
(2) Farm land:	
2,100 acres at $60	126,000
2,225 acres at 20	44,500
(3) Railroads:	
Branch of B. & O. R. R. running from Confluence to Kendall; submerged, 11 miles; damage	165,000
(4) Roads; ordinary earth:	
19 miles; damage	15,200
Total ascertained damages	$650,700

The results of the examination are summarized in Table V.

TABLE V.—RESERVOIRS OF MORE THAN 10,000 MILLION CUBIC FEET CAPACITY PROPOSED IN MONONGAHELA RIVER BASIN.

Name.	Capacity million cu. ft.	Minimum probable cost.	Leighton's estimate.
West Fork River ...	24,700	$8,190,920	$946,010
Buckhannon River..	18,800	2,703,088	992,640
Cheat River	23,800	6,686,968	911,540
Tygart River	19,100	6,451,240	1,008,480
Ten-Mile Creek	15,200	14,688,444	802,500
Youghiogheny River.	20,270	12,433,484	776,341
Total	121,870	$51,154,144	$5,437,571
Per million cu. ft.....		$419.74	$44.62

As stated before, any one who thinks the unit prices used should be modified can readily calculate the result of any desired change. It is not expected that any reasonable modification would very materially affect the conclusion, which seems to be warranted, that Mr. Leighton's estimates are utterly inadequate. Any one familiar with the cost of property usually paid by the Government under condemnation proceedings would hesitate very much to class the damages as insignificant, as Captain Adams has done, for some villages submerged, and would be inclined to allow liberal increase in many of the damages estimated. Moreover, it should be noted that the damages listed relate only to the submerged areas. It is certain that the value of adjoining property will be extensively affected. This is obvious from a brief inspection of the accompanying map (Fig. 3) showing one of the larger reservoir sites on which one can note some of the difficulties in the way of transportation that will be imposed on the adjacent region by the existence of a reservoir varying a hundred feet or so in elevation of water surface.

Assuming for the sake of illustration that the unit cost found for these six large reservoirs ($419.74 per million cu. ft.) may be applied to other portions of the system, we find totals, as follows:

For Monongahela River Basin	$72,757,721
For Allegheny River Basin	44,521,956
For Ohio River Basin	901,915,895

It is of some interest to note in this connection that this higher unit cost obtained by the above rough approximation is still below the figures given by Mr. Troté in the paper mentioned. For large reservoirs under advantageous conditions, excluding natural lakes, he considers unit costs ranging from $546 to $819 per million cu. ft. (10 to 15 centimes per c. m.) as being very low. In view of these figures and the reported cost of about $1,800 per million cu. ft. for the new Croton Reservoir, and about $1,600 for the Ashokan Reservoir, it would seem that a unit cost of $30 per acre foot or about $690 per million cu. ft. would hardly be excessive for a preliminary estimate of the proposed Ohio River system. This would increase the above totals more than 50%. In any case, it is feared that the enormous cost of the project will probably render it impracticable, however alluring it may have seemed on first consideration. It appears doubtful, therefore, whether such a plan can be prosecuted on a scale of sufficient magnitude to satisfy the pressing needs either of navigation or of flood protection on large rivers. On the other hand, it seems reasonable to expect that the growing demand for water-power development and for water supply systems will lead to the construction of reservoirs in increasing numbers, so that in the course of time their aggregate capacity on any particular drainage area may come to have an appreciable influence on stream flow.

THE OHIO RIVER is at an exceptionally low stage of water, owing to the long drought. It was reported on Oct. 2 that navigation had ceased between Pittsburg and Cincinnati, the depth of water being insufficient for even light-draft vessels. The reports stated that in consequence the U. S. Lighthouse Inspector had given orders not to light any of the 235 lights between these points, which condition had not existed for 12 years. A few light-draft steamers were still running between Cincinnati and Louisville, but were liable to be tied up. On Oct. 2 the official report stated that the water level at Cincinnati was 1 ft. above the lowest stage on record and was still falling.

THE MASSACHUSETTS GAS AND ELECTRIC COMmission in a recent report on the rates of the Boston Edison Illuminating Co. summarized in the "Electrical Review," Sept. 24, has disapproved the so-called "maximum demand" system of fixing the charges for service. This commission holds that it is impracticable to attempt to determine the cost of supplying each customer or to proportion the charges so that the customer pays a just share of the cost and profit in furnishing him with service. The company has in the past divided its expenses into fixed and operating costs much after a general practice. The first class contained all expenses that do not vary with the demand for current and included dividends and cost of general management. The running expenses have been proportioned among the consumers according to the output shown on the operating records. The fixed charges were figured per unit of maximum demand on the station as shown by the operating records. As the sum of the maximum demands of the customers was greater than the resultant maximum demand on the station, "diversity factors" were introduced to reduce the customer's maximum demand in proportioning his share of fixed charges. The company held that the cost of service to small customers was greater proportionately than to large customers and a system of sliding-scale discounts was arranged to relieve the larger customer. The Commission held that while "diversity factors" were essential, in any scheme of proportioning the fixed charges to the demand of customers, they were impracticable to obtain as it was necessary to first divide the company's fixed charges according to the proportions of different classes of business, such as lighting or power. The Commission emphasized the need for a simple and easily understood system of charging and recommended a reduction of the existing rates. The reduction was accepted by the company but the incorrectness of its charge system was not admitted.

THE IMPROVEMENT OF THE OHIO RIVER FOR NAVIGATION.

The Ohio River and its tributaries form one of the most extensive and important systems of inland navigation in this country. The aggregate length now made available for navigation is nearly 2,000 miles, of which the Ohio River represents 967 miles. The improvement of the river for the purpose of facilitating navigation has been in progress since 1824, and the works have been on an increasingly large scale as the growth of traffic has increased the requirements. The earlier improvements were for the purpose of maintaining a minimum navigable depth of 3 ft. In 1875, a 6-ft. depth was adopted, and in 1905 this was again increased to 9 ft. The expenditures for the general improvements made by the government from 1827 to June 30, 1908, aggregated about $6,863,000. This is for work on the open river, exclusive of dams and locks and also exclusive of $3,906,000 for the canal and works at the Falls of the Ohio. The works still required to secure and maintain a 9-ft. stage of water from Pittsburg to the mouth of the river at Cairo are estimated to cost $63,731,500. All the improvements have been carried out according to the plans of and under the direction of the Corps of Engineers of the U. S. Army.

A great amount of engineering work has been done on the Ohio River, and the work is still in progress. The most extensive work, however, is that recommended recently by a board of engineers, and which provides for continuing the improvement throughout the entire length of the river at a cost of over $63,000,000, as noted above. In view of the importance of the Ohio River as a commercial route, and in view also of the present movement in favor of developing inland navigation, it will be of interest to present some particulars as to the characteristics, the traffic and the improvement works upon this river. Much of our information is taken from the annual reports of the Chief of Engineers, and from a report made by a special board of engineers which was presented to Congress early in 1908. It has been pointed out in the annual reports above mentioned that commerce and navigation could not derive the full benefit of the improvements until all these are completed, as the available draft for vessels is limited by places where the depth is less than that provided at places where improvements have been made. Continuous work on a definite scheme of improvement for the entire river is necessary therefore to produce the desired results.

The Ohio River has a length of 967 miles from its commencement (formed by the junction of the Allegheny and Monongahela rivers) at Pittsburg, Pa., to its mouth at Cairo, Ill., where it flows into the Mississippi River. With its tributaries it drains an area of about 210,000 sq. miles, having a population of about 12,000,000. Its discharge is constantly varying. The highest stages are usually from the beginning of February to the end of April, and the lowest stages from the beginning of August to the end of October. Throughout the year there are occasional floods of short duration. The discharge at the head of the river is about 1,600 cu. ft. per sec. at low water, with a maximum flood discharge of about 440,000 cu. ft. per sec. Navigation is stopped not only by low water, but also by ice; stoppages from this cause average 10 to 12 days each year. There are several ice harbors for the protection of shipping, but the loss of vessels due to the ice is sometimes very great. The river is crossed by 27 bridges, and 15 of these were reported in 1903 as being obstructions to navigation, owing to insufficient length of the channel spans.

The slope of the surface of the river at low water diminishes gradually from an average of 11.4 ins. per mile between the Davis Island dam and Wheeling (85.3 miles), to 3.7 ins. per mile between Paducah and Cairo (67 miles). The total fall is 424 ft., of which 26 ft. are at the Falls of the Ohio, near Louisville, Ky.

The river has a succession of natural pools formed by bars. Most of these bars are of sand and gravel, but some are of solid rock or hardpan, as at Beaver, Pa., and Grand Chain (near the mouth of the river). The Falls of the Ohio, at Louisville, are formed by an irregular mass of limestone. They are dangerous for navigation except at very high water, and formerly were impassable during the greater part of the year. The canal to pass navigation around the Falls was opened in 1830, and the navigable channel in the river has been improved materially.

The principal navigable tributaries of the Ohio, are the Allegheny, Monongahela, Muskingum, Little Kanawha, Kanawha, Big Sandy, Kentucky, Green, Wabash, Cumberland and Tennessee rivers. On all of these the government has undertaken improvement works. According to a paper presented by Mr. J. W. Arras before the Engineers Society of Western Pennsylvania, there are 68 dams on these streams (12 being movable dams), and these afford a total of 958 miles of slackwater navigation. Other locks and dams are under construction, and on the Tennessee River there is a canal 18 miles long, with 11 locks.

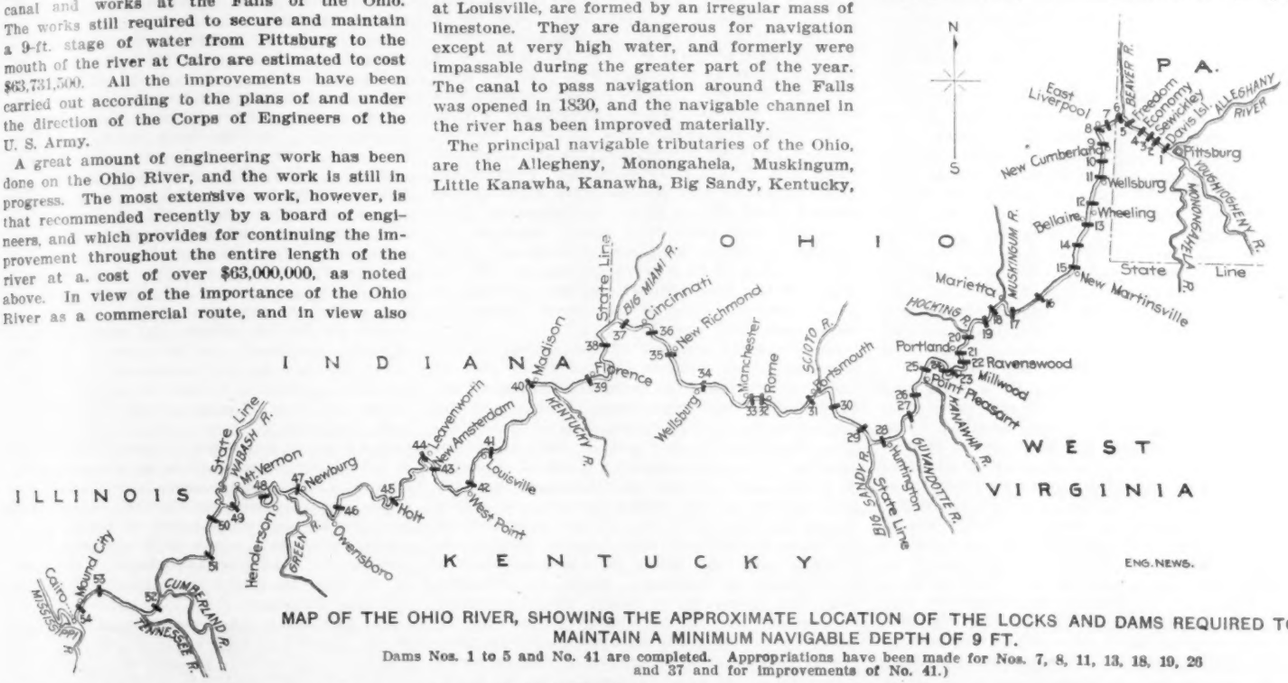
As shown by the annual reports of the Chief of Engineers, U. S. A., the open channel improvement of the Ohio River was commenced by the general government in 1827, when low-water navigation over many of the bars and shoals was impossible for commercial purposes. The work has included dredging and rock excavation at bars and shoals, the removal of snags and rocks from the channel, the construction of low dikes and wing dams to concentrate and direct the flow of water in improved channels, and the protection of banks and construction of levees.

A survey of the Ohio River below Louisville (and down the Mississippi to its mouth) was made in 1821 by the U. S. Engineers. In 1824 an appropriation of $75,000 was made for the improvement of certain sand bars and the removal of snags. In 1825 the construction of the first dike was commenced, this being at Henderson, Ky.

In 1825 the State of Kentucky granted a charter to a company for the construction of the Louisville & Portland Canal, to pass navigation around the Falls of the Ohio. This canal was opened in 1830. The United States government was one of the original stockholders in this company, and increased its holdings until in 1855 it owned all the stock, with the exception of five shares held by directors to qualify them for office. The directors continued to manage the canal until 1874, when the five shares were purchased by the government, which then assumed control. Between 1868 and 1873 the government had made appropriations for increasing the navigable depth, and appropriations for further improvements have been made since 1874. The canal, with its approaches, is about three miles long. It has a double-lift lock, with two chambers 80 × 310 ft., giving a combined lift of 26½ ft. at low water. The old triple-lift lock built in 1825 is now occupied by a bear-trap weir. The plans of the board of engineers noted below provide for enlarging the canal and building an additional lock, 85 × 600 ft. The river is not entirely closed by the dams, but there is an open channel (the Indiana Chute) which is navigable in both directions at high water, when the falls are drowned out.

In 1830, work was begun on the removal of rocks at Grand Chain. In 1831 and 1832 dikes were constructed at certain points. The first permanent work above the falls was the dam at Brown's Island, 60 miles below Pittsburg. This was built in 1836. Appropriations for improvement work were made regularly from 1826 to 1844, but from 1845 to 1866 only two small appropriations were made. Upon the resumption of appropriations in 1866 the improvement by works of contraction was recommenced. The general project provided for the regulation of depth by two methods: (1) closing side channels or chutes at islands by means of dams; (2) narrowing the main channel by dikes projecting from the bank in order to concentrate the current so as to remove the bars. These methods are still in use for practically the entire length of the river. They are supplemented by the removal of obstructions and the dredging of channels through bars and shoals.

The improvement of the channel by such regulating works as the dikes and cut-off dams would be sufficient to maintain a minimum navigable depth of 3 ft. But at an early date it was recognized that a 6-ft. depth would be necessary to provide for the coal fleets which form the greater part of the traffic. It would be impracticable to obtain this depth by any system of open-river regulation.



MAP OF THE OHIO RIVER, SHOWING THE APPROXIMATE LOCATION OF THE LOCKS AND DAMS REQUIRED TO MAINTAIN A MINIMUM NAVIGABLE DEPTH OF 9 FT.

Dams Nos. 1 to 5 and No. 41 are completed. Appropriations have been made for Nos. 7, 8, 11, 13, 18, 19, 26 and 37 and for improvements of No. 41.)

Investigation showed that the best system of improvement, therefore, would be the construction of a series of dams and locks, at least in the upper part of the river. The first proposition for such a system was made in 1870 by the late Wm. Milnor Roberts, M. Am. Soc. C. E. This is the system now being carried out. The use of movable dams has been adopted in order to provide free or open navigation in the river at high water for the fleets of coal barges. The locks are used only at low-water stages. Up to 1907 five dams had been completed and nine authorized, leaving 40 more to be provided for extending the 9-ft. channel throughout the entire length of the river.

In 1872, the Chief of Engineers, U. S. A., appointed a board of engineers to report upon certain plans for movable hydraulic gates for locks and qhutes. In 1874, Major Wm. E. Merrill, U. S. A., who was then in charge of the Ohio River improvements, proposed a plan for securing a minimum navigable depth of 6 ft. from Pittsburg to Wheeling (about 90 miles). This was adopted by Congress in 1875, but not without considerable opposition on the part of the navigation interests, who failed to realize the benefits that would result to them. The plan provided for 13 movable dams, with locks for use when the dams were raised. It was notable for its recommendation of the Chanoine or wicket type of movable dams, which had been used previously in France. Major Merrill, however, introduced a number of improvements upon the French design. In 1875 he further expressed himself in favor of extending the movable dam system throughout the river, at least as far the falls at Louisville. He was not sure of the advisability of applying the system to the lower part of the river, but considered that even there it was better than a system of permanent dams. Either permanent or movable dams, however, would be required to secure a depth of 6 or 7 ft. at low water.

In 1875 the River and Harbor Act appropriated $100,000 for "the construction of a movable dam, or a dam with adjustable gates, for the purpose of testing substantially the best method of permanently improving the navigation of the Ohio River and its tributaries." This provided for a practical test of the system proposed by Major Merrill. The dam was built at Davis Island (4.7 miles below Pittsburg), under the direction of Major Merrill, and was put in service in October, 1885. This was the first movable dam with Chanoine wickets in this country, and proved so successful that the same type of dam has been adopted for most of the movable dams on the Ohio River and its tributaries. The dam proper, across the navigable channel, is in all cases supplemented by movable weirs (generally of the Chanoine or bear-trap types) for regulating the level of water in the pool above the dam. The locks provide for navigation when the dams are raised. They have rolling gates of the type designed by Major Merrill.

The River and Harbor Act of 1881 directed the appointment of a board of engineer officers to report upon the improvement of the river below Pittsburg by means of movable dams. This board recommended four dams below the Davis Island dam (No. 1.). The plan was adopted, but the number was afterwards increased to five; dam No. 6 to be just below the mouth of the Beaver River. The first appropriations were made in 1890, and four of these dams are completed, Nos. 3, 4 and 5 having been finished in 1907-1908.

In 1896, an act was passed for a survey of the Ohio River from Pittsburg to Marietta, O., and calling for a report on the number of movable dams required to provide a minimum navigable depth of 6 ft. between these points. In 1898, Col. (then Major) Wm. H. Bixby, submitted a definite plan for improving the river from dam No. 6 (below Beaver, Pa.) to dam No. 18 (below Marietta, O.), at an estimated cost of $850,000 for each dam. This plan was adopted, and appropriations have been made for several of the dams.

In 1899, an act similar to the above was passed in regard to that section of the river between Marietta and the Big Miami River (about 12 miles below Cincinnati). In 1902, Col. (then Major) Bixby presented a report locating dams Nos. 19 to 38 inclusive; No. 38 was to be about 503 miles below Pittsburg. These were all to be movable dams with locks, costing from $950,000 to $1,000,000 each, the total estimated cost for the 25 dams and locks being $19,950,000. This plan, somewhat modified and with the number of dams reduced to 18, was sanctioned by Congress. Appropriations for some of these have already been made. The lowest one, No. 37 (below Cincinnati), is one of the most important. It will be the longest movable dam in the world. This is now under construction.

The improvement works being well under way, their important relation to the river traffic became evident. The question of enlarging the scope of the project by increasing the channel depth then began to be considered. A depth of 6 ft. had been adopted in 1875 for the first section of the upper river to be improved by means of dams. The River and Harbor Act of 1902 provided for an investigation as to the increase of depth below Dam No. 1 (Davis Island). A board of engineers recommended that in order to meet the demands of traffic a depth of 9 ft. should be provided from Dam No. 1 to No. 7. This recommendation was approved, and the River and Harbor Act of 1905 included appropriations to secure the increased depth by modifications in the locks and dams Nos. 2 to 6 (both inclusive). Further appropriations for this purpose were made by the Sundry Civil Act of 1906. The proposed Lake Erie and Ohio Canal (for which Congress has granted a charter to a private company) is to have a depth of 12 ft. Should this be built the depth of the river channel may be increased to 12 ft. from Pittsburg to the Beaver River (the lower end of the canal).

As a natural sequence of the system of improvement thus adopted for the upper part of the river (Pittsburg to Cincinnati, 480 miles), the extension of the improvement throughout the entire length of the river began to be considered. The River and Harbor Act of 1905, therefore, directed the appointment of a board of engineers to report upon: (1) the canalization of the river and the cost of the works necessary to secure depths of 6 ft. and 9 ft.; (2) the possibility of providing for the demands of traffic without additional locks and dams; (3) the possibility of maintaining an increased depth by dredging from the Green River (about 18 miles above Henderson, Ky.) to the mouth of the Ohio at Cairo, Ill. The board, as appointed, was composed of the following officers of the Corps of Engineers, U. S. Army: Lieut.-Col. D. W. Lockwood, Lieut.-Col. E. H. Ruffner, Lieut.-Col. C. B. Sears, Major George A. Zinn and Major Wm. L. Sibert.

The report of the board was made in December, 1906, and recommended the construction of works for a 9-ft. channel throughout the river. This report was referred (as provided by law) to the Board of Engineers for Rivers and Harbors for review. This latter board, after a personal inspection of the river and holding a public hearing at Pittsburg, made its report in October, 1907. This board coincided in the conclusions presented by the special board, and recommended the improvements as proposed by that board. In January, 1908, the report was finally transmitted to the Secretary of War by Gen. MacKenzie, then Chief of Engineers, U. S. A., who endorsed its conclusions very emphatically.

The two minor points noted above (Nos. 2 and 3) may first be disposed of. As to any other system of improvement than that now in force, the board reported that the probable demands of traffic (present and prospective) cannot be provided for by any other plan of improvement not having locks and dams, or having a less number of such works than those proposed in the report.

As to dredging below the mouth of the Green River, the board reported that a 6-ft. depth can be maintained, but that a 9-ft. depth cannot thus be maintained economically. The dredging plant for the 6-ft. project would require eight large hydraulic dredges at $200,000 each, with $27,000 per annum for maintenance and operation. As the life cannot be taken at over 20 years, 5% of first cost must be added for depreciation, making the total annual cost $296,000. For the 9-ft. project, 20 dredges, at $250,000 each, would be required. The total annual cost for maintenance would be $600,000, and this must be added 5% of first cost for deterioration, making a total annual cost of $[illegible]. These amounts represent a capitalization of $7,400,000 and $21,250,000, respectively, at 4% per annum. The first cost of canalizing this part of the river by dredging is estimated at $12,2[illegible]9 for the 6-ft. and $13,852,000 for the 9-ft. project. The annual outlay for operation and maintenance would be $90,000 and $105,000, respectively. The serious objections to any dredging project for maintaining the desired depths are the lack of permanency and the immense plant required to obtain quick results at critical times. All of this plant lies idle (at great expense) for the greater part of the year, and much of it may be idle for several years, owing to the eccentricities of the low-water stages.

As to the main question of the canalization of the river, the board reported that a 6-ft. navigable depth at low water can be established in the Ohio River from Pittsburg to Cairo by means of 45 movable dams with locks (including those already built). A 9-ft. depth can be established by means of 54 dams and locks. The estimated cost is $50,962,266 for the 6-ft. project, and $63,731,488 for the 9-ft. project. These amounts are in addition to funds hitherto appropriated and authorized. All the money necessary for a 9-ft. depth from Pittsburg to Beaver has been appropriated already, as noted above. The annual cost of maintenance is estimated at $15,000 for each lock and dam, making $810,000 per annum for the 9-ft. project. The reviewing board, however, considered that this maintenance cost is too low, and should be increased to $1,000,000 per year in order to provide for necessary dredging in the pools. The recommendation made by both boards and by Gen. MacKenzie, U. S. A (while Chief of Engineers), is for the 9-ft. project. A list of the dams is given in the accompanying table, and their approximate location is shown by the accompanying cut. As Congress has already authorized works to secure a 9-ft. channel at certain points, it is not likely to revert to the shallower 6-ft. channel. In regard to the cost, the Chief of Engineers makes the following remarks:

> The estimated cost in both cases is materially increased by the necessity of making provision for the present unique method of coal transportation on the Ohio River, a method which has been developed by long experience, which has cut down the cost of transportation to a figure unprecedented in the history of commerce, and which is apparently so well grounded on sound economical considerations that it cannot and should not be disturbed.

Up to Aug. 1, 1908, of the 41 dams from Pittsburg, Pa., to Louisville, Ky., inclusive, which are involved in the maintenance of a 9-ft. stage, six dams had been completed, eight were under construction, and the site for another purchased. No funds have yet been appropriated for the three dams required between No. 37 (12 miles below Cincinnati) and No. 41 (at Louisville), but the Louisville dam is now being rebuilt in accordance with the present project for a 9-ft. stage. No provision has been made by Congress for dams between Louisville, Ky., and Cairo, Ill., although (as noted above) the Board of Engineers charged with the examination of the Ohio River, has reported in favor of extending the canalization of the stream so as to give a 9-ft. stage to its mouth. If this project is carried out it will involve the ultimate construction of 54 dams, as follows: 41 from Pittsburg, Pa., to Louisville, Ky., inclusive; 13 from Louisville, Ky., to Cairo, Ill. The total cost of these 54 dams is estimated at about $64,000,000.

From a study of the gage records it is estimated that movable dams for a 9-ft. depth of water would have to be operated about 14 times a year in the stretch between Pittsburg and Wheeling, six times a year at Cincinnati, and five or six times a year below Louisville. The estimate includes both complete and partial movements. The storage effect of the dams as the improvement of the river proceeds down

streams from any point will, it is thought, control to some extent the moderate rise and prolong the length of the naturally navigable stages of the river below.

The question of traffic was considered at some length by the special board, which estimated the present amount at about 13,000,000 tons per annum. The board of review, however, called attention to the frequent duplications (the same shipment being reported once as shipped at a certain point and again as received at another point). After a careful consideration of the returns this latter board put the amount at 9,375,000 tons. The great proportion of the traffic moves down-stream, but in view of the facilities which canalization will offer to up-stream navigation, it is estimated that the improvement would result in a very large future commerce in both directions. This would include commodities which (from their low value and large bulk) cannot be handled to advantage unless such cheap facilities are offered as those due to water transportation. An extensive commerce in iron and steel products and other manufactures is predicted. The cost per ton-mile for coal is estimated at 0.0653 ct. for the 6-ft. project and 0.0447 ct. for the 9 ft. project. Thus the cost of transportation of coal from Pittsburg to Cairo would be 63.14 cts. and 43.25 cts. per ton for the 6-ft. and 9-ft. projects, respectively.

In connection with the river improvement works, it will be of interest to consider the commercial side of the project. The river traffic is carried on by packet boats and towboats. The former are steamboats carrying passengers and freight; they accommodate local traffic by handling small shipments and making frequent landings. For large quantities of freight, a towing steamer with barges is employed. For this latter service stern-wheel steamers are considered the most suitable. They have from three to five balanced rudders, 20 to 30 ft. long. When the wheel is reversed a strong current is deflected against the rudders, thus facilitating steering, whether the boat is still moving or not. According to the report of the special board of engineers already mentioned, a stern-wheel steamer of about 1,000 HP., will leave Pittsburg (on suitable stages of water) with about 12 coal boats and 3 barges. After passing the Bellaire Bridge (96 miles), 5 more coal boats will be added, making a total cargo of about 18,500 tons for the 20 boats. The steamer will take its tow to Louisville (passing through the canal). From Louisville to New Orleans larger steamers are used, and a boat of the most powerful class will tow from 30 to 60 boats, each loaded with about 1,000 tons of coal or other similar commodities.

The board estimates that freight in less than carload lots would be delivered in less time by water than by rail. The packet steamers average about 120 miles per day (including stops) when navigable depths are always available. A towboat with barges will make the trip from Pittsburg to Cincinnati (468 miles) in four or five days, to Louisville (598 miles) in five or six days, and to New Orleans (2,020 miles) in 16 to 18 days. It is remarked that the decrease in navigation in recent years is due largely to the unreliability of the stage of water. Under such conditions there has been little inducement for the proper development of wharves and freight-handling facilities or machinery at river ports.

As to the cost of transportation, the board estimates that a transportation company having as much as 3,500,000 tons of low-grade freight to transport from Pittsburg or other Ohio River points to New Orleans, could carry coal on a 6-ft. stage of water at a price not over 0.5 mill per ton-mile (including the return of the empty craft). This is on the supposition that the freight is offered in 1,000-ton lots and with sufficient regularity to keep the plant moving except during extreme floods and for a few weeks each year when ice may interfere. The price includes maintenance and 5% interest on investment, and is about 12½% of the average railway rate on similar commodities.

About 90% of the freight is coal, which is loaded in barges drawing from 5½ ft. to 8½ ft.

TABLE OF LOCKS AND DAMS FOR A 9-FT. NAVIGABLE CHANNEL IN THE OHIO RIVER.

Dam No.	Distance from Pittsburg, miles.	Elev. above sea level. Upper pool surface, ft.	Lower lock sill, ft.	Appropriations—Made. (Dam completed)	Appropriations—Required.	Location of dam.
1	4.7	703.0	690.3			Davis Island
2	9.0	699.9	682.6	"		Merriman Bar
3	10.9	692.1	674.9	"		Sewickley, Pa.
4	18.6	684.4	667.2	"		Economy, Pa.
5	23.9	676.8	659.3	"		Freedom, Pa.
6	28.8	668.3	652.5	.....	$70,000	Beaver River
7	36.9	662.0	644.7	$23,000	1,004,800	Georgetown, W. Va.
8	46.1	655.7	637.3	460,000	746,595	Near E. Liverpool, O.
9	55.6	649.3	630.9	.....	1,100,000	New Cumberland, W. Va.
10	63.5	641.9	622.5	.....	1,240,000	Brown's Island
11	76.3	633.5	615.1	460,000	693,093	Wellsburg, W. Va.
12	87.0	626.2	606.8	.....	1,320,000	2½ miles above Wheeling
13	95.8	617.8	601.0	712,000	398,000	Bellaire, O.
14	114.0	610.9	591.2	.....	1,100,000	Near Fish Creek Island
15	129.0	602.2	583.4	.....	1,200,000	New Martinsville, W. Va.
16	146.4	594.4	575.6	.....	1,200,000	Near Petticoat Ripple.
17	167.4	586.6	567.4	.....	1,240,000	Below Carpenter's Bar
18	179.3	578.4	561.2	655,000	177,000	8 miles below Muskingum River.
19	191.4	572.5	553.5	25,000	825,000	Below Little Hocking River
20	201.4	564.5	545.0	.....	1,280,000	Below Big Hocking River
21	213.8	556.0	539.0	.....	1,200,000	Portland, O.
22	220.0	550.0	532.6	.....	1,200,000	Ravenswood, W. Va.
23	229.6	543.6	524.5	.....	1,200,000	Millwood, W. Va.
24	241.5	535.5	517.5	.....	1,200,000	6 miles below Letart's Falls
25	260.0	528.5	508.5	.....	1,150,000	4 miles above Pt. Pleasant
26	274.0	519.5	502.5	135,000	965,000	9 miles below Kanawha River
27	288.5	513.5	496.1	.....	1,240,000	Below Little Guyandot River
28	309.0	507.1	487.5	.....	1,240,000	4 miles below Guyandot River
29	320.1	498.5	479.5	.....	1,240,000	4 miles below Big Sandy River
30	339.0	490.5	472.0	.....	1,280,000	Jeannette shoals
31	358.6	483.0	464.5	.....	1,320,000	3 miles below Scioto River
32	383.4	475.5	457.0	.....	1,380,000	Rome, O.
33	396.6	468.0	450.0	.....	1,240,000	Manchester, O.
34	431.0	461.0	444.0	.....	1,440,000	Wellsburg, Ky.
35	449.8	455.0	438.0	.....	1,440,000	New Richmond, O.
36	460.0	449.0	430.1	.....	1,440,000	8 miles above Cincinnati, O.
37	481.3	441.1	422.3	550,000	500,000	13 miles below Cincinnati
38	503.3	433.3	415.0	.....	1,240,000	14 miles below Big Miami River
39	528.0	426.0	407.0	.....	1,450,000	Florence, Ind.
40	552.8	418.0	401.0	.....	1,620,000	Near Madison, Ind.
41	604.0	412.0	372.0	75,000	1,760,000	Louisville, Ky.
42	624.5	383.0	365.6	.....	1,360,000	3 miles above West Point, Ky.
43	652.5	376.6	359.2	.....	1,480,000	New Amsterdam, Ind.
44	660.3	370.2	352.8	.....	1,280,000	Leavenworth, Ind.
45	700.1	363.8	344.4	.....	1,580,000	Holt's bar
46	748.5	355.4	336.0	.....	1,720,000	4 miles above Owensboro, Ky.
47	772.0	347.0	327.0	.....	1,720,000	Newburg, Ind.
48	804.3	338.0	318.0	.....	1,840,000	25 miles below Green River
49	830.6	329.0	309.0	.....	1,640,000	8 miles below Mt. Vernon, Ind.
50	859.2	320.0	301.0	.....	1,480,000	19 miles below Wabash River
51	876.8	312.0	292.0	.....	1,584,000	Near Shawneetown, Ill.
52	912.5	303.0	283.0	.....	2,248,000	3 miles below Cumberland River
53	947.0	294.0	276.0	.....	2,800,000	Grand Chain, 23 mi. below Tennessee River
54	962.0	287.0	267.0	.....	2,260,000	Mound City, Ill.
Telephone line				.....	310,000	
Total				.....	$33,731,488	

At low water the barges are stored in certain pools until a rise of the river affords sufficient depth of water over the shoals. The barges are then taken down the river by steamers, each of which has a large fleet or "tow." This method of transportation affords a cheaper means of handling freight than usually obtains on canals and improved rivers. In fact, it is stated that coal has been shipped from Pittsburg to New Orleans at a rate less than 0.04 mill per ton-mile. The project for improvement by locks and dams for a 9-ft. channel depth is designed to interfere as little as possible with this method of transportation. Each dam has a wide pass for navigation; this can be lowered when the river rises, so as to leave free passage for coal fleets. The locks will allow the smaller fleets to pass unbroken when the dam is raised. It is estimated that 20,000 tons can be locked through from one pool to another in 1½ hours.

The improvement could be made at less cost by the use of fixed dams and smaller locks. But it is considered that this saving would not be justified, as it would be a great hindrance to the most important traffic and would destroy the economy in transportation which has been obtained by the method of handling coal in large fleets. On the other hand, it has been suggested that with improved navigation the necessity for these large single fleets (made large to get the greatest possible movement at a favorable stage) will be diminished, and that there will be a tendency to more frequent movement of moderate fleets, both down-stream and up-stream.

In conclusion, we give the following quotation from the letter written in January, 1908, by Gen. A. MacKenzie (then Chief of Engineers, U.S. A.) in transmitting to the Secretary of War the reports made by the two boards in 1906 and 1907 relative to the improvement of the Ohio River:

> There is no hope for success in the development of such a commerce as is predicated for the Ohio River by any other method of improvement than the one proposed. It is possible that a further study of the situation and a thorough revision of the project might reveal the possibility of reducing the number of locks and dams slightly and giving higher lifts to the latter, thus accomplishing better results at slightly decreased cost. But I entertain no doubt whatever that the development of a large future commerce, seeking the river in preference to other methods on account of the increased convenience and diminished cost of freight movement, depends absolutely upon a method of improvement which will have a tendency to remove or minimize the present vastly different conditions between up-stream and down-stream traffic. The unprofitableness of the up-stream movement has always been a drag upon the down-stream movement, whereas every increment of the up-stream traffic on a profitable basis will have a tendency to decrease the cost and increase the amount of down-stream traffic. The greatest disparity of conditions between the down-stream and up-stream freight movement resides in the current, which hampers both, though not equally.
>
> The pronounced advantage of lake over river transportation is very largely the result of the absence of current in the former. It follows that a scheme of improvement of the Ohio River promising success must present as one of its features a diminution of current, which cannot be attained in any appreciable degree by any open-channel method.

TWO NOTEWORTHY IDAHO IRRIGATION PROJECTS are reported by J. G. White & Co., 43 Exchange Place, New York City. Of one the company states that it has begun surveys

for Mr. F. H. Buhl, of Sharon, Pa., for the reclamation of about 700,000 acres of arid land in southern Idaho. The project is practically an extension of the noted Twin Falls development. Water supply for the proposed extension will be obtained from Snake River. The lands lie to the west of the Twin Falls tract beyond Salmon River and in part beyond Bruneau River. The surveys in progress include reservoir sites, the enlargement of the present Twin Falls Canal, which was developed by Mr. Buhl, to a capacity sufficient to carry the increased water supply, an extension of the main canals to cover the lands of the project including a siphon to carry the water supply across Salmon River Canyon, which is about 1,650 ft. wide and whose bed is 500 ft. below the level of the proposed canal. Five surveying parties are already in the field at work on the various parts of the project.

Of the other project the company says that it has begun to construct for the Idaho Irrigation Co., Limited, a complete irrigation system for about 150,000 acres of land situated in southern Idaho. The water supply for this project will be obtained from Big Wood and Little Wood rivers. The lands to be irrigated are in the vicinity of Shoshone, Richfield and Gooding. The irrigation system will consist of a storage dam, four diversion dams, four main channels, each leading to one of the tracts of land into which the project is divided and the complete system of distribution and drainage ditches necessary for the irrigation of these lands. The storage dam, which will form a reservoir of more than 150,000 acre-feet capacity, is to be built in the channel of Big Wood River, in a lava canyon and is to be about 115 ft. high, of rock-fill type, with concrete core. The diversion dams, two of which will be in the channel of Big Wood River and two in the channel of Little Wood River, are relatively small structures of sufficient height to raise the water to the level of the canals. The aggregate length of the main canals will be more than 75 miles, varying in capacity in proportion to the areas of the tracts to be irrigated. The largest canal will have a capacity of about 760 sec.-ft. Distributing canals and ditches will be built over the entire area to reach every quarter section of land.

BRAKE TESTS OF HYDRAULIC TURBINES.

By G. EVERETT QUICK,* E. E.

Efficiency in the utilization of water-power is coming to receive more careful attention, on the part of manufacturers and users of water-wheels, as the cost of fuel rises and therefore the value of power increases. The large modern installations have had the benefit of later engineering knowledge in the design and setting of the wheels, and develop high efficiencies. Many of the small and medium-sized plants, however, are exceedingly inefficient. The low efficiency may sometimes be an inherent fault in the design, but in many instances tests have shown that the efficiency could be very materially improved by a change in the setting, in speed or in some other detail. For example, where wheels are set in pairs it is often found that they are set too close and the discharges interfere with each other, causing a loss in efficiency.

Most manufacturers of wheels, not having suitable facilities for testing, have made a practice of having this done by the Holyoke Water Power Co. at its testing flume at Holyoke, Mass., which, for years, has done most of the commercial water-wheel testing in this country. For comparative purposes and under similar conditions these tests fully meet their purpose, and the results have greatly aided in the development of the modern wheel. Obviously, no matter how well a wheel may show up in this test, it may give poorer results under the normal conditions of installation; as previously suggested that depends on what the special conditions are. In consequence many owners of hydraulic plants which are troubled with insufficient water during certain periods of the year or high water charges have found it desirable to learn whether maximum power or best efficiency is being obtained with their equipment.

The necessary test for determining this requires equipment for accurately measuring the quantity of water, the head under which it operates, and the power developed.

Several good methods for obtaining the quantity of water are in common use. Which to select depends upon the specific conditions. A current-meter is ordinarily used in the head-race and gives very satisfactory results if the meter is carefully calibrated and the head-race is of reasonably uniform cross-section. When this device cannot be used, recourse is often had to a standard measuring weir constructed in the tail-race. This subject is treated fully in text-books on Hydraulics. In general it may be said that the measurement of flow presents no special difficulties. The same thing is true of the measurement of head, including the draft-tube vacuum. On the other hand, accurate measurement of power developed is likely to prove a troublesome problem, especially in the case of large units, 500 to 1,000-HP. and larger.

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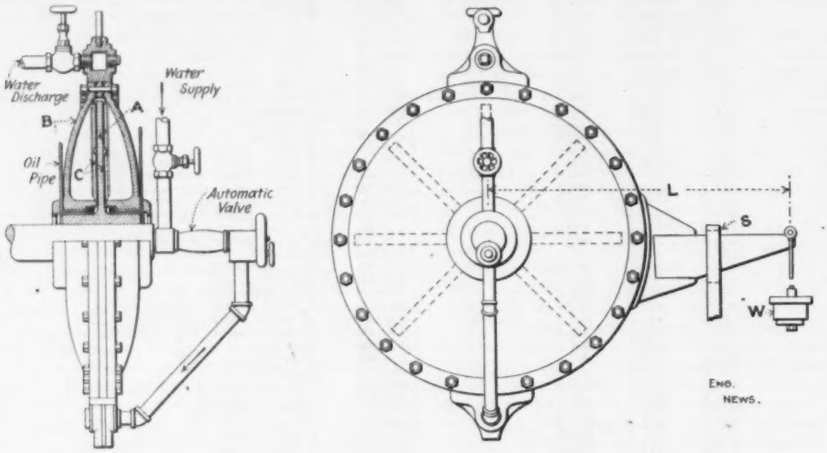
The best known and least expensive form of dynamometer for absorbing and measuring mechanical power is the Prony brake. This type of brake is used exclusively at the Holyoke testing flume; it gives satisfactory results within their capacity limits (300-HP. maximum). Those who have attempted to use a single Prony brake for absorbing greater power realize the difficulty involved in removing the heat generated and in minimizing the other inherent disadvantages of this form of brake, so evident with high amounts of power.



Sectional End Elevation. Side Elevation.

FIG. 1. ALDEN BRAKE, ORDINARY TYPE.

Where the water-wheel drives an electric generator it becomes a very easy matter to determine the efficiency of the combined unit. However, unless the efficiency characteristics of the generator are accurately known, the performance of the water-wheel cannot be separated from that of the unit with sufficient precision.

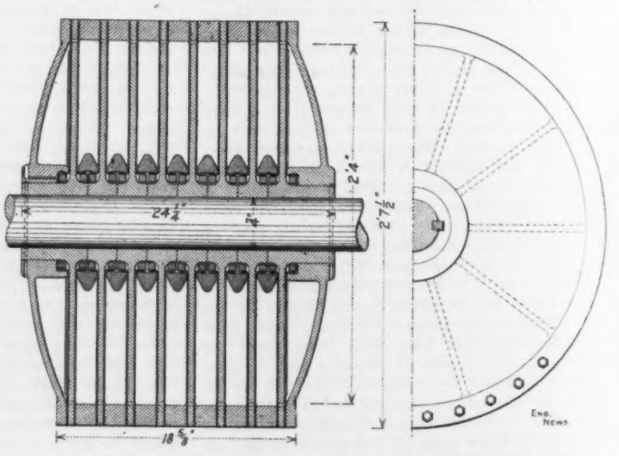
The need of a suitable absorption dynamometer for high powers has resulted in the development of the Alden brake to meet these requirements. The ordinary Alden brake has a single friction disk; by building it with a number of disks and friction plates in a single casing it is made capable of absorbing a very much higher power, and in this form it proves very suitable for tests of large hydraulic turbines.

The ordinary or single-disk Alden brake is shown in Fig. 1. The rotating member is a smooth circular cast-iron disk A with radial grooves, rigidly keyed to the shaft; the shaft of the brake is coupled to the shaft which transmits the power to be absorbed. A stationary casing B having its bearings upon the hub of the revolving disk, completely encloses the latter. Two thin flexible copper plates C are attached to the casing at both hub and rim, forming water-tight compartments with it. Through a system of piping water is admitted to these chambers under variable pressure and the consequent variation in pressure and friction between A and C changes the load. Flexible pipe connections allow a circulation of oil between the friction members to reduce the wear and permit smooth operation. The water supply not only furnishes pressure but by its circulation removes the heat generated. A supply furnished at variable pressure is maintained constant inside the brake by means of an automatic regulating valve at the inlet. The friction of the disk tends to force the casing to rotate with it, and the force required to prevent this rotation is a measure of the power absorbed. The latter is computed from the speed of rotation in revolutions per minute N, the horizontal lever arm L, and the unbalanced weight W at the end of that arm: $H\,P = .0001904\,L\,N\,W$. The casing is kept from rotating beyond prescribed limits by the stops S.

As the formula just given shows, the power capacity can be increased, for given speed of revolution, only by increasing the torque $L\,W$. Increasing the pressure between the plates and disk (raising the water-pressure) or increasing the area of the disk by using a larger disk, will accomplish this object. There are practical limits in both these directions, however, and to adapt the brake to higher powers it was found necessary to group several disks in parallel. Each added disk requires an additional narrow water compartment, but this does not increase the size of the casing very materially. Doubling or tripling the capacity by adding disks adds but little to the size of the brake. Fig. 2 shows a four-disk brake.

With small single-disk brakes the influence of the weight of the brake on the bearings is negligible. The entire counterbalancing weight is suspended from the end of the lever arm L, Fig. 1, without trouble from bearing friction or bending of the shaft. With the greater weight of the multiplex brake, however, it has been found advisable to arrange a lever system which will relieve the shaft of the duty of carrying the brake. Fig. 3 illustrates such an arrangement. Instead of a single weight-arm as in Fig. 1, this arrangement has two arms, L and M, which are pulled in opposite direction by weights at W and X, the latter acting through a cross-lever F suspended from the hanger-rod O. With such an arrangement a very perfect balance may be secured, by proper adjustment of lever-arms and weights. In some recent tests of wheels developing over 2,000 HP. (Fig. 4) the entire weight of brake and shaft (about 6 tons) was so nicely counterbalanced that the nearest required running bearing was that of a water-wheel about 7 ft. distant from the brake. The levers are usually so designed so that at 100 r. p. m. a one-pound weight on the outside arm or ten-pound weight on the inside arm indicates 1 HP.

The largest dynamometer built at the present time consists of four 60-in. disks and has a capacity of about 3,000 HP. at 200 r. p. m. The capacity is limited by the amount of heat that can be transmitted through the copper plates; the temperature range, the quantity of cooling water and the quality of lubricating oil regulate this. For a test of several hours' duration a system of forced lubrication using a cheap grade of cylinder oil and admitting the oil at the periphery is essential for the smooth operation of large units. Gravity lubrication, where the centrifugal force carries the oil from the hub along the radial grooves in the disk to the periphery gives satisfactory results with small units.



Longitudinal Section. Half End Elevation.

FIG. 2. MULTIPLE-DISK BRAKE OF ALDEN TYPE.

The largest power ever absorbed at one time by the large brakes mentioned was 4,100 HP., developed by a pair of turbines under a head of 110 ft. at a speed of 225 r. p. m. On either side of the turbine a brake was mounted in place of the pulp-mill grinders which regularly used the power. Fig. 4 shows one of them partially installed with oil and water-pipe connections.

The work required to make such tests is comparatively small when the amount of power is considered. Two units of approximately 4,000 HP. were tested in a little less than three days.

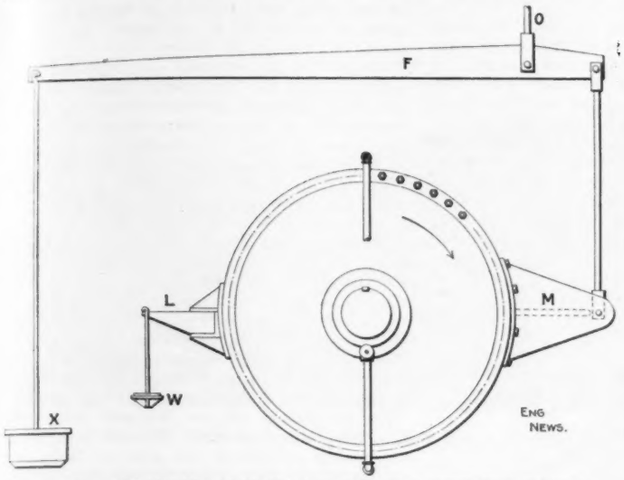


FIG. 3. BALANCED LOADING LEVERS FOR FRICTION BRAKE.

The amount of labor involved in setting the brake for such a test varies widely, depending on local conditions. If the brake can take the place of and run in the same bearing as the driven machine, such as electric generator, grinder, etc., the work is greatly simplified. As the oil and water must be supplied under pressure, some form of pressure pump is ordinarily required.

Some idea of the normal operating conditions found in practice may be gained from the fact that in tests made by Prof. Chas. M. Allen, of the Worcester Polytechnic Institute, on a pair of large wheels it was found that 30% to 40% greater power and efficiency were obtained by merely reducing the average running speed. Normal speed had been so high that the wheels did not even "run away" when the entire load was removed. Too high a speed seems to be a prevailing defect in hydraulic plants.

When the wheels receive a fair setting and the speed is properly chosen the efficiency curve will very closely conform to that obtained at the Holyoke flume when the wheels were new. By a "fair setting" is meant one which allows the water to approach the vanes at a low velocity, has a shaft no larger than necessary, the draft-tube air-tight and designed to meet any special conditions, and the wheels (if in pairs and center discharging) set sufficiently far apart to avoid interference of the two bodies of discharge water.

A NEW PULSATOR JIG for the concentration of ores has been developed from a principle discovered by Prof. Robt. H. Richards of the Massachusetts Institute of Technology. So effective is the application of this principle that a Richards jig with a capacity of 90 tons per day, compared with an equivalent jig of the ordinary type, is seen to have but 1/20 the weight and to require only 1/200 the screen area and 1/5 the horse-power. The method of concentration is, in its general features, merely a modification of the Herz system in common use. Its novelty lies in the absence of plungers and eccentrics. It employs, instead, for producing the pulsations of the water stream required for the separation of the mineral "pulp," a rotating valve of peculiar design. The pulsations imparted by this valve are characterized by an absence of the inert period, or suction, typical of the ordinary method. To this feature is attributed the comparatively enormous capacity of the new jig, it being claimed that the reverse impulse of the water in the common type causes a blinding of the screen and tends to undo the work of the upward stroke. The rotary valve is operated at about 200 pulsations per min. A description of this jig and of the Richards classifier, employing the same sort of pulsations, was published in "The Engineering and Mining Journal" of Sept. 26.

STEAM CARS AND SPECIAL LOCOMOTIVES FOR RAILWAYS OF LIGHT TRAFFIC.

Light railways and local secondary railways are extensively used in Europe, and considerable attention is given to the methods of handling the light traffic in such a way as to combine economy with a sufficient service. The ordinary arrangement of a locomotive and train of cars is so expensive that only a minimum service can be operated, and this does not tend to develop traffic. The use of steam motor cars and other types of special equipment is therefore very general. A report on this subject was presented at the recent congress (at Munich) of the International Street Railway and Light Railway Union, by Mr. Herman R. Von Littrow, Chief of Motive Power of the Austrian State Railways. From this report we take the particulars given below.

The traffic requirements of small towns and districts call for fairly frequent service and fair speeds, but the earnings are not sufficient to pay the cost of operation of ordinary trains. Where mixed trains are used, the service is inconveniently slow, and attempts to operate fast passenger trains with locomotives designed for slow mixed trains have not been satisfactory. With the introduction of steam motor cars there has been effected a combination of good service and speed with low cost of equipment and operation. Only in a few cases have unfavorable results been reported.

The principal difficulties incident to the steam motor cars are as follows:

1. The small size of the boilers (to reduce weight) and their high power and evaporation. Theoretically, such a boiler should be of advantage, owing to the readiness for increasing the steam capacity at steep grades. In practice, however, the small boiler requires so much attention that it cannot be left to the engineman. Even with a fireman, however, the results are not satisfactory. The small tubes become scaled and fouled, and the cost of repairs is high. This difficulty is not found with the steam cars of English railways, as they have usually boilers of ample size and capacity.

2. It is difficult to keep the car clean, as it must go to the shops when the engine requires repair or cleaning, and is then soiled by smoke and dirt.

3. The engine and boiler require much more frequent repair than the car body, and the latter is out of service therefore for a greater time than it should be.

4. The engineman must give increased attention to watching the track when the machine is running reversed. If operating levers are placed so that he can control the machine from the rear end, a fireman is necessary. In some cases, the conductor can operate the whistle and brake from the front end when running reversed. But this is not satisfactory, as he has to attend to the tickets, mails, parcels, etc. The Northern Ry. of France has overcome this difficulty by putting the engine room at the middle of the machine, and setting the car body slightly off the center line, so as to give the engineman an unobstructed view in either direction. It is not desirable to separate the engineman and the fireman. If the machine must be turned at each end of its trip, the traffic will be hampered at the busiest times, as on market days and holidays.

5. The greatest difficulty is that of affecting an economical arrangement of trains made up with motor cars and trail cars, which trains may be necessary at times of heavy traffic. The arrangement usually involves a large crew.

The adoption of steam cars has been hindered to some extent by the publication of unduly favorable statements of the cost of operation by persons interested in their introduction. In many cases an average for monthly or annual cost is based upon the results obtained with an experimental machine used for a short time on a line having favorable conditions, and no allowance is made for the repairs which would be required for the machine if kept in continuous service. A railway company adopting a steam car service on the basis of such estimates may find its equipment insufficient to maintain this service when some of the cars are under repair.

All attempts to retain the advantages and to eliminate the disadvantages of steam cars have been in the direction of separating the power equipment from the car proper. This gives practically a light locomotive which may be operated by one man. The Adams (1849), Weissenborn, Brunner and Rowan machines were of this class. The second was in service for many years at Paris, on a line having a loop terminal. It gave entirely satisfactory results. The Rowan cars were in use on the Gross-Lichterfelde Ry. from 1889 to 1905. In both these cases, the machines were abandoned only when electric traction was introduced. Most of the steam cars of English railways are built on this same principle. This separable or detachable arrangement eliminates many of the difficulties already noted as incident to the combined or self-contained system.

Another type of steam car has the baggage compartment on the same frame with the locomotive, the passenger car being separable. This

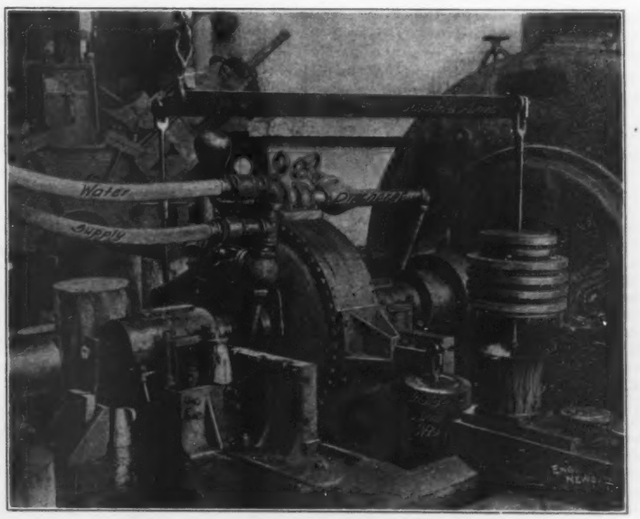


FIG. 4. VIEW OF 60-IN. FOUR-DISK BRAKE.
(Connected with a pair of turbines of 2,000 HP. at 225 r. p. m.)

type has been used for some of the private railways in Hungary (Elbel and Goisdorf cars), the Belgian and Italian state railways (Belpaire cars), the Hanover state railways (Von Borries cars), and the French and Hungarian state railways. In this type of machine nearly all the objections noted above are obviated. If the baggage compartment is made somewhat narrow

(or put to one side of the center line), the engineman can see ahead even when the engine is running backward. Trains can be made up conveniently and handled by a small crew. In spite of these advantages, however, the machines of this class are disappearing.

The present tendency is to employ small locomotives which are entirely independent of the car or train. Several machines built by Krauss & Co. in 1879 and 1880 are still in use, and give a lower weight per passenger than any other similar machines. In 1880, Mr. Lentz, of the Hohenzollern Works, designed engines of this class, but having cylinders placed between the axles in order to give a steadier and smoother motion on the rails. No fireman is required. Experiments made with different types of steam cars on the Austrian state railways, led the mechanical engineer, Mr. Golsdorf, to design a new type of light locomotive. This burns liquid fuel on the Holden system, and dispenses with the use of a fireman, thus cutting the wages expense in half. Some of the Golsdorf engines, however, burn lignite; these are on lines where the enginemen refused to operate machines without the assistance of firemen. A modified design for hauling fast local trains on main lines burns coal and is handled by two men; only one axle is driven, there being no coupling rods. As a result of the satisfactory performance of the liquid-fuel engines with one man, the Austrian state railways have converted some old tank locomotives to this system, on plans prepared by Mr. Von Littrow, the author of the paper from which we take our information.

An auxiliary local train service on main lines is sometimes operated by steam cars. In 1884, the Netherlands state railways introduced special light trains or "tramway trains" for this class of service, the cars being of the type used on street railways (or tramways) and hauled by light locomotives. In 1887, also, the Northern Ry. of France adopted a similar system, utilizing old passenger engines which were too light for the main-line trains. These light local trains stopped at all stations and at road crossings. In this way, the railway company prevented the construction of a system of local or interurban lines which would have been in competition with it.

Mr. Von Littrow closes his report by stating that the experiments with steam cars of the self-contained and separable systems on the Austrian and Hungarian state railways have resulted in favor of the latter system, using special light locomotives. He points out, however, that the results are not conclusive, since the conditions of operation on these lines were not those of the ordinary light or local railway.

In conclusion we may note that a number of steam cars of different types, used on American and foreign railways, have been described in our columns.

CEMENT CONTRACT FOR THE ISTHMIAN CANAL.—The Isthmian Canal Commission asked for bids for furnishing about 4,500,000 bbls. of Portland cement, for use in the locks at Gatun, Pedro Miguel, and Miraflores. Of this amount, approximately one-half will be used at Gatun, one-sixth at Pedro Miguel, and one-third at Miraflores. Bids were opened on June 1. A large number of tenders were made, offering cement of American and foreign manufacture. The lowest bid was that of the Atlas Portland Cement Co. The prices were $1.19 per barrel in wood, and $1.00 per barrel in double bags of Osnaburg duck, these prices being for delivery at Jersey City or Hoboken, and a rebate of 8½ cts. being allowed for each bag returned in good condition. The company also offered to deliver at the works at Northampton, Pa., the cement packed in bags or barrels, to be furnished by the Commission, at 65 cts. per bbl. Award has been authorized to the Atlas Portland Cement Co., reserving to the Commission the right to elect the method of delivery under certain conditions to be specified in the contract. The delivery is to be at a minimum rate of 2,000 bbls. and a maximum of 10,000 bbls. per day, and will begin between May 1 and Oct. 1, 1909, upon 90 days' notice to be given by the Commission.

The cement for the spillway in Gatun Dam will be furnished under this contract, but the delivery will begin December 1, 1908, and continue at the rate of 500 bbls. per day, this date not affecting the date of beginning deliveries of the main amount under the contract. It is expected that about 80,000 bbls. will be needed for the spillway.—"The Canal Record."

A LARGE CONCRETE SEWER CONSTRUCTED WITH ADJUSTABLE METAL FORMS.

By JOHN M. BRUCE,* Assoc. Am. Soc. C. E.

An excellent example of novel methods in concrete form work as well as of economical handling of men and materials is furnished by a large sewer contract now being executed by James Pilkington in Bronx Borough, New York City. The contract covers about 7,100 lin. ft. of reinforced-concrete outfall sewer, of horseshoe section varying in size from 6 ft. by 5 ft. 11 ins. to 11 ft. 6 ins. by 7 ft. 3 ins.

The sewer discharges into the East River on the bulkhead line at the foot of Truxton St. Its upper end consists of two branches (see Fig. 1) joining in Leggett Ave. at Whitlock Ave., just north of the Harlem Division of the New York, New Haven & Hartford R. R. One of the branches begins at the intersection of East 156th St. and Tinton Ave., and extends down East 156th St. and Leggett Ave. to the junction; the other begins at Longwood Ave. and Southern Boulevard, and extends along Longwood and Whitlock Aves. to the junction. From this point

Fig. 1. Diagram of Contractor's Plant, Truxton St. Outfall Sewer and Branches, Bronx Borough, New York City.

the outfall sewer extends southerly, crossing under the railway and then going along Leggett Ave. and Truxton St. to the outfall. The main sewer is 11 ft. wide by 7 ft. 2 ins. high for the upper 1,685 ft., increased to 11 ft. 6 ins. by 7 ft. 3 ins. for the lower 1,015 ft. of length. The branches are 6 ft. by 5 ft. 11 ins. for the East 156th St. branch (2,800 ft. long) and 6 ft. 3 ins. by 6 ft. 1½ ins. for the Whitlock Ave. branch (1,580 ft. long).

The crossing of the main sewer under the railway right-of-way was built by the railway company and does not form part of the present contract. The 11-ft. sewer terminates at the southerly edge of the right-of-way; the crossing as well as a short length (about 100 ft.) between its northerly edge and the junction of the two branches is of the same size (6 ft. 3 ins. by 6 ft. 1½ ins.) as the Whitlock Ave. sewer.

This series of sewers is cut in two parts by the railway right-of-way, which is not bridged at Leggett Ave. (a bridge here is now under construction by the railway company) but can be crossed by overhead bridges on East 156th St. and on Longwood Ave. The contractor began work on both sides of the railway, working southward on the outfall portion and north and east on the Whitlock Ave. branch. The East 156th St. branch is soon to be begun, working north from the junction at Whitlock Ave. The arrangements for handling materials to and from the work were determined by this division of the work and by the location of the bridges over the railway.

EXCAVATION.—Most of the main sewer is through a soft and slippery clay. This is being excavated with a 1-yd. orange-peel bucket, which is taking out an average of 70 cu. yds. a day (including time lost in moving plant). This section is nearly all sheet piled, with 4 x 10-in. plank. The contractor is required to leave the sheeting in place, as well as to lay a flooring of similar material, on piles, under the sewer. The foundation piles, about 1,000 in all, are driven with a 4,000-lb. steam hammer fitted with sliding extension leads so that the hammer, mounted with its engine on a bull-wheel and running on skids laid along either side of the sewer, loses no time in driving from the piles to the bottom of the sewer, 25 to 30 ft. below the base of the driver.

For driving the sheeting an interesting rig is used. A light two-drum hoist engine, one drum of which operates simultaneously two 2,000-lb. hammers, is set on a platform supported by skids like those of the large pile-driver. These two hammers are placed one on either side of the sewer and each drives two sheet-piles at once, and as they operate simultaneously, four sheet-piles are driven in one operation. The other drum of the engine is used for moving the plant along the line of the sewer and for the derrick that hoists the sheeting into place.

About midway of this main sewer was found about 2,000 yds. of good quality rock. This latter is being put through a crusher set alongside the trench, with its hopper immediately over a narrow-gage railway, which takes the crushed material to the main storage bins and mixer.

The excavation for the Whitlock Ave. sewer has been almost entirely through rock. Two Lidgerwood cableways are used in taking out the material. They dump directly into carts on the bridges at 156th St. and Longwood Ave., respectively. The loaded carts cross the bridges and go southeast a quarter mile to a dump. Thence they proceed to the main storage hoppers on Leggett Ave. and take back to hoppers at receiving stations a load of sand or stone, whenever there is any to be hauled. The round trip is about 3,000 ft. There are 12 of these carts, and they have been averaging 50 cu. yds. of stone and earth per day.

The section on Longwood Ave. has been excavated with a 2-ton steam shovel which the contractor intends to use on a large part of the East 156th St. branch sewer excavation, soon to be started.

There has been no moving of earth from the bank of the sewer along Truxton or Leggett Sts. because the contract calls for filling up to street grade, which is 6 to 10 ft. above the natural ground surface, and it may even be necessary to bring in some material to complete this part of the contract.

SUPPLY OF MATERIALS.—All of the sand and stone, with the exception of the crushed rock, above referred to, comes by barge to the dock at the foot of Truxton St. The barges are unloaded by clam-shell directly into cars on an industrial railway laid along the line of the main sewer, and these carry it to the main storage bins, located just south of the New Haven railroad crossing, as shown in Fig. 1. A small overhead hopper on the dock (capacity about 80 cu. yds.) permits the unloading to proceed even when all the cars are full. From the main bins the aggregates are delivered to distant sections of the job by team, as previously described. The main sewer is supplied with concrete from a mixer alongside the bins by the cars of the industrial railway. Through the use of these overhead storage bins, with the main mixer alongside, and the separate storage bins over the mixers on the other sections, much handling of aggregates is eliminated.

The main storage and mixing plant is shown by the photograph Fig. 2. Immediately in front of the bins is seen the traveling mixing plant, supplying the main sewer in Leggett Ave. and Truxton St. Material is delivered to the mixer direct from the side-dump industrial cars, which carry 1-cu. yd. buckets, each of which is divided so as to hold a correct proportion of sand and stone for a 1:2:4 mixture. These buckets are filled from the bins by a clam-shell operated from the bridge abutment in the back-

*47 West 34th St., New York City.

grouted. The cement (Giant) is, of course, delivered to the mixer in its original bags. The mixer is mounted on rails and the mixer engine is used also for moving it along the track as the work progresses. This plant offers a very simple and ingenious solution of the vexing problem of handling mixtures on sewer work, where of the sewer. These bands serve three purposes: first, they furnish a bottom member to the assemblage of outer sheet and corrugated sheet, and thus make a Warren truss possessing great bending strength; second, they permit the forms to be adjusted to any required curve; and third, they give a means of lapping consecutive tric washers also on the bolts of the fish-plates which are used in joining the sections.

The lower section on either side is connected to the main part of the assembled form by hinge instead of by fish-plate, as Fig. 4 shows. By swinging the lower sections inward and upward the entire form can be lowered so as to enable

FIG. 2. MAIN STORAGE BINS AND TRAVELING MIXER AT UPPER END OF MAIN SEWER, LEGGETT AVE., SOUTH OF N. Y., N. H. & H. R. R.

usually very little actual mixing can be done without moving the plant.

REINFORCEMENT.—The sewer is a heavily reinforced-concrete shell, 9 ins. thick at the crown and 12 ins. thick at the center of the floor. The disposition of the reinforcement on all parts of the work is identical. There are two layers of circumferential rods, staggered. These are ¾-in. twisted steel rods 10 ins. on centers; the two layers are 5 ins. apart radially. The reinforcement of the invert is similar. At the junction of the sides with the invert there are short rods 4 ft. long, extending 2 ft. into the invert and lapping the arch reinforcement by a similar distance, one for each circumferential rod. Longitudinal rods, ½-in., 12 ins. apart, are wired to the inner layer.

The specifications called for the wiring together of all reinforcements at the laps. It would seem to the writer from observation of the progress of work on these sewers that the advantage of continuous reinforcement secured by this practice is more than offset by the evil effect of the impossibility of keeping voids out of the concrete at this point.

CONCRETING.—The chief feature of the concrete work, and one of the principal novelties of the whole contract, is the use of "Duralite" metal forms (see Eng. News Jan. 30, 1908, p. 116) for the inside of the sewer. These were rented by the contractor from the Duralite Co., 42 Broadway, New York City. Fig. 3 shows them in sectional form as furnished and also as erected in a complete arch form.

Two sets of forms are used, one for the large and one for the small sewer, although one set could be adjusted to either curve. This is done only because Mr. Pilkington is building both sections at once. The forms for the large section, shown in Fig. 3, are made of 16-gage sheet steel with 3-in. corrugations, and the units for the smaller sections are made of 18-gage steel and 2-in. corrugations.

These forms are made up of standard units 8 ft. long and 23 ins. wide. The exact circumferential width is secured from these units by the addition of wooden strips on the bottom edges of the lowermost pieces (Fig. 3). The outer surface of the form consists of a plain steel sheet, to which is riveted an inside corrugated sheet to give the required stiffness and eliminate any necessity for interior centering or bracing. On the under side of the corrugated sheets are attached by adjustable means a number of flat bands, varying in number from three to five per 8-ft. section, according to the size sections, so as to ensure perfect alinement without any extra labor.

The curve adjustment is secured as follows: The bands are attached to the sheet by T-headed bolts, whose nuts bear on washers having the hole eccentric to the outer circumference, which latter fits into a circular counterbore in the band. The units, which are shipped to the job flat (saving much freight and handling cost) are bent to the required curvature over a template, on the job, by workmen sent with them for the purpose. After being bent over the template, they are held rigidly to this shape by setting up the bolts, with proper position of the several eccentric washers. They then require no further adjustment until it is desired to change their radius once more. Still further range of adjustment is secured by using eccen-

it to pass through the next form ahead. For the purpose of alining the successive sections of completed form, the band at one end of each section is set so as to project one inch beyond the form, while the band at the other end is set an inch back of the end. This produces a 1-in. lapping of successive sections so that when a section is set against one already erected it comes naturally into exact alinement. When so set, clamps are sprung over the adjoining end bands, which holds the new section rigidly in place.

It will be seen that a form of any size or shape can be made up from these standard units, the only limitation being that as the diameter of the sewer increases, thicker steel and deeper corrugations are necessary in order to give the required strength. The manufacturers furnish the

FIG. 3. "DURALITE" ADJUSTABLE METAL FORMS FOR INSIDE MOLDS OF ARCH, TRUXTON ST. OUTFALL SEWER.

(The separate sections lying at the left are bottom sections for the arch form; regular sections do not have the wooden strip and are fitted for a fished joint instead of for hinging. The wooden filling in the corrugations consists only of short blocks at the ends, protecting the ends against battering.)

forms with corrugations 2, 3, 4 or 5 ins. deep, of 18 to 12-gage steel, for diameters from 3 to 20 ft. These forms make it possible to conduct the concreting as a continuous operation, an important advantage as concerns both economy and quality of work. They also give a remarkably smooth surface finish, difficult to obtain with other than metal forms.

On this work the forms are left in place two days after the concrete is placed. The average progress per day is 24 ft., and a sufficient number of forms for three such lengths is therefore required. The rearmost 8-ft. section is struck by drawing in the hinged lower edge pieces and is lowered down upon a curved support frame (see Fig. 4). It is then able to pass forward through the forms in place, to the front end of the erected forms, where it is raised again and, by swinging the edge pieces outward, is set

FIG. 4. FRONT VIEW OF "DURALITE" FORM PASSING FORWARD THROUGH ERECTED FORMS, 6-FT. SEWER.

in place ready for the concrete. This operation takes 4 men 30 mins. per 8-ft. section, or 1½ hrs. for 24 ft. At an average cost of 25 cts. per hour for the labor, which is slightly higher than its cost on the job in question, the labor cost for shifting is $1.50, to which must be added 50 cts. as the outside cost for the labor of sectioning and greasing the forms between each use. The cost for labor is thus $2, and as the 24-ft. length has about 456 sq. ft. of surface, the unit cost of moving forms is 8⅓ cts. per lin. ft. of sewer, or 0.44 ct. per sq. ft. of surface.

These forms, in the writer's opinion, embody the chief desiderata of forms for concrete work, as follows: (1) Non-absorbent forms make the best concrete; this form, being made entirely of steel, is necessarily non-absorbent. (2) Certainty of correct alinement; owing to the method of assemblage and the lapped end-joints, this is very fully secured. (3) Smoothness of the concrete surface; this is naturally attained through the use of smooth and greased steel forms. (4) Facility of applying heat by salamanders, for winter work; with steel forms there is no danger from fire. (5) Repair and maintenance cost low; the figures obtained from about a dozen jobs on which these forms were used indicate that maintenance cost is so low as to be really negligible. (6) Cost of moving and setting low; the figures given above show the very low cost on the Pilkington work. (7) Lightness; the weight per square foot of these forms for a 6-ft. sewer is about 4 lbs. per sq. ft., while wooden forms of equal strength would weigh at least 16 lbs. per sq. ft. (8) Unobstructed bore; this feature is of high importance, since it gives a free path for men, material and forms. It is almost essential to continuous operation.

These forms are not used on the curved portions of the sewer, except where the change of angle is so gradual that it can be taken up by 1-in. offsetting at the outer edge of the joint between the 8-ft. lengths of form. The other curves are concreted over wooden inner forms.

House connections (tile) enter the sewer all along its length. On most of the cross streets there are existing sewers which must be connected up; these are generally tile sewers. The connection is made simply by setting into the outside form planking a tile trimmed at its inner end to the curve of the inside form, and concreting this tile into place. The same method is used for setting inlets for the discharge pipe of catch-basins.

The invert of the sewer is concreted without forms, but is spaded roughly to section, screeded true, and floated with a ½-in. finish coat. It is allowed to set 3 or 4 days before the arch work is begun. The outside forms for the arch are of plank, braced by studding held from the sides of the trench. The concrete is used quite wet; its consistency determines the required height of outside form. The top is left open, of course, and is screeded to the required outline.

The top of the invert where the arch will foot is left very rough, for making a good joint. The 4-ft. joint-lengths of reinforcing rod, already mentioned, further strengthen the joint. No trouble has been experienced in getting a good bond between arch and invert concrete.

The concrete for most of the work is moved from mixer to work in side-dump cars running on the narrow-gage track alongside the trench. Chutes are set at the head of the work, discharging the concrete directly into place in the forms; the cars dump into the chutes, without shoveling or other intermediate handling.

COST OF ELECTRIC COOKING.—In the London "Electrical Engineering," Sept. 17, is an article in which results are given of practical electric cooking in the Oxford St. branch of the Fleming restaurants of London. All the chops, steaks, poached eggs, etc., are cooked by electricity. The toasters and grills are built with the heating elements and a reflector above the food and with an asbestos pad above the reflector. The use of this type of grill has been much more satisfactory than the older kinds with the heat applied beneath. The cooking apparatus comprised a warming oven, a 1.8-KW. grill, a 600-watt egg poacher, a 5-gal. boiler, a small grill or toaster and a hot plate. The total consumption for eight days was 313 KW.-hrs., or an average of 39.1 KW.-hrs. With power at 2¼ cts. per KW.-hr. (1½d.) the daily cost was about 88 cts. This is an average of about two cents per hour for each appliance used. Actually the cost of running the egg-poacher, hot plate, etc., was about 1.5 cts. per hour each, and for the large grill, capable of cooking 12 chops or steaks at once, the cost per hour was about three cents.

IRON-SLAG BLOCK FOR STREET PAVING.

During the past summer the Borough of Brooklyn, N. Y., received bids for the paving of several of its streets with iron-slag block, and as certain interests took occasion to fight the letting of the contracts, this little-known paving material received considerable publicity. As a good many municipal engineers are unacquainted with the block, a short account of its use and qualities seems proper.

Iron-slag blocks—by this meaning the poured molten blocks and not crushed slag mixed with lime or cement, a distinction which will be made later—have been used in small quantities in Europe, especially in England, and some 15 or 20 years ago were introduced into several cities in this country and in Canada. In the great majority of these pavements the block was imported from England, a certain furnace in that country and a few on the continent being the only ones turning out the product, although a plant in Pennsylvania manufactured the block for a short time about twenty years ago. These pavements on this side of the ocean have now been down a long enough time to demonstrate their wearing qualities. The general opinion of the city engineers who have had them under observation is that in but few qualities is the material superior to the asphalt or brick granite which it is meant to supplant, while in many it seems to be inferior. Information on the subject is rather hard to procure, but that here recorded is largely the result of correspondence and interviews with the few engineers who are in a position to give testimony on the subject.

So far as can be learned, the iron-slag block has not been made for commercial purposes in this country, except by the Pennsylvania plant noted above, which was in business but a short time. Several plants in England are producing the block according to the following scheme:

> In the Cleveland district some blocks are produced by the following process: Slag of suitable quality is run from the furnace into a ladle-car, from which it is poured into cast-iron molds secured to the periphery of a horizontal wheel. Each mold has a hinged bottom, and as the wheel is slowly rotated the bottoms of the mold are released in succession. The blocks, which are solid on the surface, but molten inside, are dropped on to a bed of granulated slag, and quickly removed and stacked in an annealing oven, and allowed to anneal without any additional heat. In about eight hours the oven is opened and the blocks withdrawn, when they are ready for use. If the blocks were merely cast and not annealed they would soon crumble to pieces from the action of internal stresses.*

An engineer who recently took steps to ascertain the attitude of the various American blast furnace operators on the subject of manufacturing iron-slag blocks reports that while many are willing to provide the slag for this purpose and to aid independent companies in the manufacture, few show any inclination to undertake the manufacture themselves. In confirmation of this report, one of the largest steel companies in the United States informs us that it has investigated the paving-block as a means of utilizing its slag, but has found it impracticable. It writes as follows:

> About two years ago we made some investigation of the question of manufacturing paving blocks from molten slag and we found that our slags are too silicious and too low in alumina, just the reverse of the slags produced abroad, to manufacture a block that would have the strength required for paving purposes. It would seem that in the annealing to which they are subjected, there are, in slags made of Lake Superior ores, no elements to influence the hardening process, while the ores used in Europe appear to produce slags which show great strength and density after annealing. A representative of one of the European firms which had to do with the manufacture of these blocks in the Newcastle district of England, spent a few days here a couple of years ago and returned to England with a number of samples of our slags, but nothing came of the idea he had of establishing a plant in this country.

The molten slag block is to be distinguished from the pressed slag block, such as was described in Engineering News, June 25, 1908, p. 701, in an article on the "Utilization of Blast-Furnace Slag." These latter blocks are made by mixing granulated slag with lime or cement and pressing them into blocks. Their compressive value is very small and they are entirely

*From the Metallurgy of Iron and Steel, by Thomas Turner, p. 180.

unsuited for the severe service required of a paving block.

In size the blocks are 8 × 4 × 3½ ins., laid with the 4-in. sides vertical, and the 8 × 3½-in. wearing surface has ½-in. chamfered edges. They are heavier than asphalt or granite blocks, of a whitish exterior and bluish interior and are extremely hard. They are likely to contain blow-holes which, when near the surface, seriously impair the wearing qualities. These are all apparent properties, evident on casual examination. No laboratory experiments of any extent are available, so that the usual paving material test figures cannot be given. One engineer reports, however, that compression tests on a limited number of specimens averaged 13,000 lbs. per sq. in. Specifications of the block are extremely limited in describing its physical properties, as the following extract from a specification of the Brooklyn Bureau of Highways will show:

The blocks shall be iron-slag block of the following dimensions: 8 ins. long, 4 ins. deep and 3½ ins. wide. The edges of the upper face of the blocks shall be chamfered. They shall be hard, durable and uniform in quality and dimension. All blocks must have good, flat, even beds and upper surfaces, with vertical sides. Blocks must be sound and perfect in all respects, free from cracks, hollows and other defects. In appearance the blocks shall show an opaque, stone-like surface, and below the outer skin a blue porcelain color.

The remainder of this specification contains directions as to methods of laying, and is quite brief. Similar specifications have recently been issued for the paving of the Queens approach to the Blackwell's Island Bridge in New York City.

The paving is generally laid in the same manner as asphalt or granite blocks, on a concrete base, with either cement or asphalt joints. The latter are preferably used, since the cement joints make so solid and unyielding a plane that the pavement is very noisy, more so than asphalt or granite, on account of the metallic nature of the slag.

These blocks have been laid on this continent in New York, Quebec, Baltimore, Philadelphia, Toronto, Richmond and Montreal, and for these cities we are able to present more or less brief accounts of the behavior of the paving.

NEW YORK.—The principal streets laid with the block are Nevins and Livingston Sts. (between the street railway tracks) in the Borough of Brooklyn. These are streets on which the traffic can hardly be called heavy, but the block, now in service about three years, has flaked badly on the surface, but otherwise presents a fairly good wearing surface. An old concrete foundation, on which a granite block pavement had rested, was utilized as the base in this work and any deficiencies in the pavement, such as irregularities of surface, may be ascribed to this unsatisfactory foundation. The consulting engineer of the department says:

The block, if homogeneous, has a useful place in our pavement problems, giving a smooth pavement which would be exceptionally hard and durable under all conditions of traffic.

The department of this borough thinks so favorably of the paving that it recently advertised for bids for five sections of street, totaling 11,665 sq. yds., all near the Bush terminals, where there is considerable trucking. There were from six to seven bidders on each contract, the low bidders naming $2.75 per sq. yd. for the iron-slag block, about the same as current prices for asphalt block in the same locality, and about 25 cts. per sq. yd. more than for granite block. On account of various political complications the awarding of the contract has been withheld.

In the Borough of the Bronx one short street was laid last year and at the present time one street is being laid, but the engineers there are not particularly well impressed with the material. In the first place, they say the blocks are quite irregular in shape and size so that special care has to be taken in laying the sand base on the concrete foundations. On account of the hard and brittle nature of the block it is impossible to cut it to regular shape and fit on the job. Once in, the pavement is very slippery, and chips to an irregular surface, so that teams generally avoid it if possible.

QUEBEC.—For the small amount laid there have been no specifications issued. The pavements, which have been in service about ten years have proved satisfactory. They are less noisy and more easily cleaned than the granite block. The cost, with curbing, on a 6-in. concrete base, was $4.25 per sq. yd.; on a 12-in. concrete base, $5.15 per sq. yd. In comparing this with the Brooklyn figures it must be remembered that the latter do not include either base or curb.

BALTIMORE.—The city engineer does not favor the iron-slag blocks, so they have not been used in the main pavements, but the street-railway company has used them in the paving between the rails and 2 ft. outside thereof, which is required of the company by law. The engineer-of-way of the railway company writes concerning this pavement as follows:

While we have used this type of improved paving in our tracks, at the same time we have not gone into this style of paving extensively. We have found that slag block can stand up under heavy traffic admirably, and have therefore had occasion to use it principally on those streets where such conditions prevail. We have used it mostly on streets which were formerly paved with sheet asphalt, and as our experience has shown us that sheet asphalt under such traffic conditions, is most unsatisfactory and expensive paving to maintain, we have therefore made a permanent disposition of these extensive repairs by the above-mentioned substitution, in which we use the same concrete base for the new paving that was used in connection with the sheet asphalt.

If Belgian block (the most satisfactory paving for street car tracks) had been substituted in place of slag block, almost the entire concrete foundation of the original paving would have had to be removed in order to permit of the use of same, while with the slag block, merely the top surface of the sheet asphalt had to be removed. Our attention was directed to these blocks by a local concern, which imports slag block from England, and upon trial, we have gotten the very satisfactory results outlined above.

I seriously doubt the advisability of using this type of paving in laying a new pavement in the street, as slag block is very expensive, besides being extremely noisy under heavy traffic, and it is not generally as satisfactory as Belgian block, as on the latter pavement, the horses are better able to maintain their footing in inclement weather than on streets where the former is used.

PHILADELPHIA.—About nine miles of streets were paved with iron-slag block about ten years ago, but on account of the extensive chipping of the edges and the unsightly appearance of the heavily traveled streets, the material was soon abandoned. No iron-slag pavements have been laid in ten years.

TORONTO.—Iron-slag is here used in some crossings and occasionaly in the railway track space, as in Baltimore, but on account of the slippery nature of the surface, the engineers do not recommend it.

MONTREAL.—The blocks have been laid here probably more extensively than in any other city, but there is very little information concerning their behavior to be had from the officials except that they have been in use for some 16 years and that they are "hard, durable, with an even top, and give every satisfaction." As in several other places the main use has been in the street railway space.

COST.

Aside from engineering consideration the question of cost and production of the iron-slag block is most important. As has been said, the block is to-day made only in England, to any extent which would make it commercially available, and further to unify the production, the English companies are under a more-or-less recognized combination, which has a single selling agency in this country through which alone the block may be bought. All of the reports from the various cities agree on a cost price of from $50 to $55 per thousand, for a product which is selling in England for $12 per thousand and which can be bought in a Canadian city by the city government for $34 per thousand. This high price is undoubtedly a result of the monopolistic nature of the product and doubtless deters many engineers from specifying the block not only on account of the extra expense but also because of the provision in many city charters against prescribing monopolistic products. Indeed, in the Brooklyn contracts cited above the bids were rejected or at least disregarded on account of an injunction granted on this very ground.

STANDARDS FOR GAS AND ELECTRIC SERVICE: ESTABLISHED BY THE WISCONSIN RAILROAD COMMISSION.

The Public Utilities Law of Wisconsin, passed in 1907, required the Railroad Commission to ascertain and fix standard conditions for the supply of any public utility product and to prescribe and establish reasonable regulations for the examination, testing and measuring of such products or service. Standards for gas and electric service in the State were established July 24, 1908, and have been published in pamphlet form with explanatory notes.

In order to properly perform the duties imposed on the Commission a number of experts were added to its engineering staff, under the immediate supervision of Mr. W. D. Pence, M. Am. Soc. C. E., Chief Engineer of the Commission, and Mr. C. F. Burgess, M. Am. Inst. E. E. The investigations and inquiries previous to fixing the standards, covered considerable ground, general and special, local and foreign.

GAS SERVICE.—The regulations imposed have been formulated to secure a service uniformly as good as that furnished by companies having the best management. It is proposed that the gas companies themselves shall conduct nearly all tests and take care of complaints. Therefore each company is required to have an approved equipment of standard measuring and testing apparatus. The Commission's inspectors are to cooperate in maintaining these equipments in proper condition by comparison with the Commission's standard apparatus. At the present time, exact specifications of methods of measuring and testing the product furnished have not been prescribed. The regulations for gas service have been formulated in the following divisions: (1) accuracy of meters, (2) heating value, (3) pressure, (4) purity of gas. The rules follow:

RULE 1. A meter may be considered as correct if, when passing gas at the rate of 6 cu. ft. per hour per light capacity, it shows, in comparison with a standard gas prover, an error which is not greater than 2%.

RULE 2. No gas company shall allow a gas meter to remain in service for a period longer than three years without checking it for accuracy and readjusting it if found to be inaccurate.

RULE 3. Each company shall keep a record of tests made on meters before installation and upon receiving them from the services.

RULE 4. Each gas company shall provide itself with equipment necessary for testing meters, such equipment to consist of a standard meter prover with suitable accessories.

RULE 5. Each gas company shall make a test of the accuracy of a meter upon request of a consumer, provided such consumer does not make a request for test more frequently than once in six months. A report giving the results of such tests shall be made to the consumer, and a complete record of such tests shall be kept on file in the office of the company.

RULE 6. Upon formal application of any consumer to the Railroad Commission a test shall be made upon the consumer's meter by an inspector employed by the Railroad Commission, such test to be made as soon as practicable after receipt of the application. For such test a fee of $2 shall be paid by the consumer making application for the test if the meter is found to be slow or correct within the allowable limits, and by the company owning the meter if the meter is found to be fast beyond the allowable limit.

RULE 7. Meter dials shall read directly in cubic feet of gas and bills rendered periodically by the company shall designate the readings of the meter at the beginning and end of the time for which the bill is rendered, and give the dates at which the readings were taken.

RULE 8. The company furnishing gas which, within a one mile radius from the distribution center, gives a monthly average total heating value of not less than 600 B. T. U., with a minimum which shall never fall below 550 B. T. U., may be considered as giving adequate service as far as the heating value of the gas is concerned.

RULE 9. Each gas company, whose output exceeds 20,000,000 cu. ft. per year, shall equip itself with a standard calorimeter outfit, with which periodic tests upon the gas shall be made. A record of these tests shall be made and kept open for public inspection.

RULE 10. Gas pressure, as measured at meter inlets, shall never be less than 1½ ins. nor more than 6 ins. of water pressure; and the daily variation of pressure at the inlet of any one meter on the system shall never be greater than 100% of the minimum pressure.

RULE 11. Each company shall make frequent measurements of the pressure and pressure variations, and these shall be kept on record and open for public inspection.

RULE 12. In no case shall the gas contain more than thirty grains of total sulphur per 100 cu. ft., and not more than a trace of sulphur as sulphuretted hydrogen.

RULE 13. Each company shall keep a record of complaints which shall include the name and address of the consumer, the date, the nature of the complaint, and the remedy. A classified summary of these records shall be submitted to the Commission on or before the twenty-eighth day of each month for the preceding month.

The Commission finds that only some 10% of the total gas consumption is by open-flame burn-

ers and where a candle-power standard would be useful. In prescribing the heat-value standard (Rule 8) the Commission has departed from a rather common practice of allowing a "net heating value," i. e., the total B.T.U. developed less the B.T.U. in latent heat of the water formed by combustion. The "total-value standard" is an attempt to standardize the gas without consideration of the devices in which it is to be used.

The determination of the total amount of sulphur in gas, the Commission holds, requires more skill and apparatus than a small company can be expected to command and it is probable that these concerns will depend on occasional tests by the Commission's inspectors. Large companies are expected to make such tests at least weekly. No restriction has been placed on the amount of ammonia in gas.

ELECTRIC SERVICE.—The Commission states that the rules governing electric service have been made as few and as simple as possible as it is believed that this industry is unsettled and unstable on account of continual and rapid developments. Adequate service has been considered in three ways: (1) accuracy of meters, (2) regulation of pressure, (3) efficiency of devices for utilizing supply. The rules follow:

RULE 14. No electric meter which registers upon "no-load" shall be placed in service or allowed to remain in service.

RULE 15. No electric meter shall be placed in service or allowed to remain in service which has an error of registration in excess of 4% on light load, half load, or full load.

RULE 16. Each electric service meter shall be tested and adjusted for accuracy at the time of its installation.

RULE 17. Each electric service meter shall be tested at least once each year; the test to be made by comparing the meter while connected in its place of service with suitable standards, on light load, half load, and full load rate of operation.

RULE 18. A complete record shall be kept of all tests made on electric meters.

RULE 19. Each company supplying electrical energy shall provide itself with suitable equipment for the testing of meters, and shall employ such methods as are approved by the Railroad Commission.

RULE 20. Each company supplying electrical energy shall make a test of the accuracy of a meter upon request of a consumer, provided such consumer does not make request for tests more frequently than once in six months. A report giving the results of such tests shall be made to the consumer, and a complete record of the same shall be kept on file in the office of the company.

RULE 21. Upon formal application of any consumer to the Railroad Commission, a test shall be made upon the consumer's meter by an inspector employed by the Railroad Commission, such test to be made as soon as practicable after the receipt of the application. For such test a fee of $2 shall be paid by the consumer making application for the test if the meter is found to be slow or correct within the allowable limit, and by the company owning the meter if the meter is found to be fast beyond the allowable limit.

Fig. 1. San Jose Potosi Dam, Mexico, Under Construction.

RULE 22. Each company supplying electrical energy shall maintain a record of all interruptions of service upon the entire system or major divisions of its systems, and include in such record, time, duration, and cause of each interruption.

RULE 23. Each company supplying electrical energy on constant potential systems shall adopt and maintain a standard average value of voltage as measured at any consumer's cut-out, which shall remain constant from day to day, and vary during any one day by an amount not more than 6% of the minimum value.

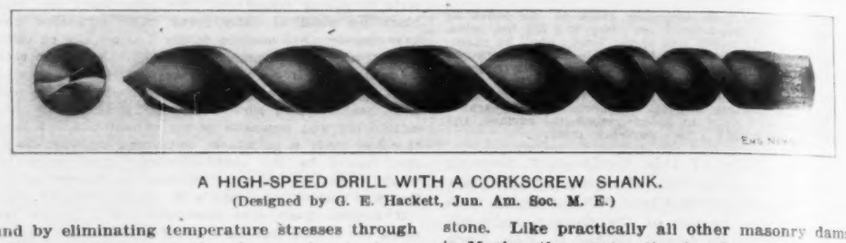
RULE 24. Each company supplying electrical energy for incandescent illumination shall adopt and maintain some method of procedure which will insure periodic inspection of incandescent lamps to which current is supplied and under which the company will render its consumers assistance in securing incandescent lamps best adapted to the operation of the system. Each company shall submit to the Railroad Commission of Wisconsin the details of such method of procedure as it may adopt.

RULE 25. Each company supplying electrical energy for incandescent illumination shall specifically inform each of its consumers as to the conditions under which efficient illuminating service may be secured from its system.

The report is signed by B. H. Meyer, Halford Erickson and John H. Roemer, Commissioners, is dated July 24, 1908, and the regulations become effective three months from that date.

A NOVEL HIGH-SPEED DRILL.

The drill shown in the accompanying figure was designed to meet the need of a high-speed tool that was less expensive than the standard type. The form evolved was not only cheaper but also stronger than that replaced on account of retaining the original forging nearly intact and by eliminating temperature stresses through having a uniform section from point to tang. The drill is formed from a rectangular bar or blank of high-speed steel and only the body is tempered. Proper clearance at the rear of the spiral edges is obtained by slight grinding. The soft shank is ground to fit a Morse-taper socket as do the more common drills. The tang fits the sockets in the familiar way, but there is much greater freedom from slipping of the taper fit of the shank under heavy loads. The tendency to untwist binds the shank in the socket and nearly eliminates the possibility of twisting off the tang as is often done with the ordinary drill and the simple taper fit. Incidentally there is a highly desirable freedom of a scoring of the sockets through breaking the shanks or tang. This design was made by Mr. G. E. Hackett, Jun. Am. Soc. M. E., while a mechanical engineer with the Central R. R. of New Jersey. This form has been found entirely successful at these shops. The first cost is about half way between that of common and high-speed steel drills in the standard shapes. The drill is being made in various sizes by the Hackett High-Speed Drill Co., 90 West St., New York City.



A HIGH-SPEED DRILL WITH A CORKSCREW SHANK.
(Designed by G. E. Hackett, Jun. Am. Soc. M. E.)

THE SAN JOSE DAM, MEXICO.

By JAMES D. SCHUYLER,* M. Am. Soc. C. E.

The city of San Luis Potosi, Mexico, will be supplied with domestic water from a storage reservoir recently completed in the vicinity, on the San Juan River, as soon as the distributing pipe system, now under construction, is finished. This reservoir is formed by a notable masonry dam called the "Presa de San Jose," or San Jose Dam, which was designed in 1896 by a Mexican engineer, Senor Sebastian Reyes. The accompanying photographs were taken by Mr. Samuel Storrow, M. Am. Soc. C. E., in November, 1901, at the time of the visit of the American Institute of Mining Engineers, who also kindly supplied most of the notes from which the following account of the work has been prepared.

As no description of this dam has ever been published, as far as I am aware, the readers of the Engineering News will be interested in learning something further of the works and achievements of their modest professional brethren across the Mexican border. The writer is indebted to the kindness of Senor Luis C. Cuevas, a civil engineer of San Luis Potosi, for copies of the drawings, from which the dimensions have been scaled. Senor Cuevas states that the reservoir has been filled several times, and has proven the dam to be entirely watertight, withstanding the strains of water pressure, without evidence of weakness. The reservoir has a capa[illegible] of 7,526,000 cu. m. (nearly 2,000,000,000 ga[illegible] covering an area of 185 acres, and receiving [illegible] runoff from 67.5 sq. mi. of mountain drain[illegible] area.

The dam is of the gravity type, of [illegible]n rubble masonry, slightly curved up-strea[illegible] with a radius of 2,000 m. (6,562 ft.). It h[illegible] a maximum height of 151 ft. from the low[illegible] foundations to the top, or 110 ft. from the [illegible]m bed. The extreme length on the crest, c[illegible]ng the spillway channels at each end, is 58[illegible] ft. The maximum thickness at the base is [illegible] ft. and about 15 ft. at the top, which is 6.5 [illegible] above the spillway level.

The profile is evidently that of the [illegible]ugnola type, with a vertical curve near the b[illegible] on the up-stream side, and also above the cen[illegible] on the down-stream face. It is built of uncour[illegible]d rubble masonry, with no stone larger than two men can conveniently carry, and mostly of one-man stone. Like practically all other masonry dams in Mexico, the construction has been made without Portland cement, using only the native lime of the country. Fortunately this has hydraulic properties, as a rule, and some of it is very excellent in quality. In this case the lime was burned on the ground and put into the work immediately without curing. The dam has a spillway channel at each end, the one on the left bank being 95 ft. wide at the dam, tapering to 52 ft. at the lower end, a distance of 120 ft. from the up-stream face of the dam. The other one is 86 ft. wide at the upper end, 36 ft. at the lower. Both are 6.56 ft. in depth.

The dam is provided with two gate towers, or buttresses, on the down-stream face, near the center. These are of unusual design and peculiarly elaborate and ornate in character, presenting striking architectural effects. They are massive and of generous dimensions.

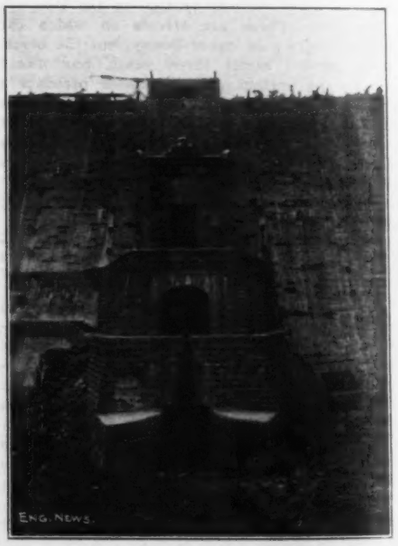


Fig. 2. One of the Gate Towers of the San Jose Potosi Dam, Mexico.

The dam was built by a private company at a cost of $400,000, Mexican silver, and is intended not only to provide water for the domestic service of the city, but also to irrigate 6,500 acres of fertile land in the valley adjacent to the city. The city of San Luis Potosi is a stockholder in the company.

*Consulting Engineer, Los Angeles, Cal.

ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering

Published every Thursday by

THE ENGINEERING NEWS PUBLISHING CO.

220 BROADWAY, NEW YORK

BRANCH OFFICES

CHICAGO: 1636 Monadnock Block
WASHINGTON, D. C.: Home Life Building
ATLANTA: Candler Building
[illegible] MOSSE, BERLIN AND HAMBURG, GERMANY
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Entered at the New York Post-Office as Second-Class Matter.

Good engineering and good common sense are marked characteristics of the conclusions and recommendations of the Fifth Report of the Royal Commission on Sewage Disposal, given in condensed form elsewhere in this issue. If these ideas are made effective, as presumably they will be, British municipalities will be enabled to shape their sewage disposal plans in accordance with local conditions rather than with highly arbitrary rules based chiefly on traditions which antedate nearly the whole of our present scientific knowledge of sewage treatment.

Among the notable conclusions thus far reached by the Commission are these: The choice between land treatment and so-called artificial treatment is one of local conditions and relative costs, rather than character of effluent obtainable by the two methods; there is still a place for chemical treatment, as a preliminary to oxidation, and it is even suggested that six hours of chemical precipitation with lime might sometimes be advantageously applied to septic tank effluents; stand-by or storage tanks are preferable to storm-water filters to care for that portion of the storm-water flow of combined sewers that may need treatment, but the volume of storm water that may be passed direct to the stream by means of overflows in branch sewers and that should have some degree of treatment should be settled in accordance with local conditions; a strong central authority should lay down various general conditions to govern sewage treatment, but between the central authority and the municipalities there should be interposed either river boards or the county councils, these district authorities to have supervisory powers, subject to appeal to the central authority; the general conditions laid down by the central authority should be subject to modification to meet district or local conditions.

So far as American and British conditions are similar, most of the conclusions of the Royal Commission are in accord with the best American practice—both on sewage works and state control or central supervision of their design. As regards central supervision, the parallel must of course be drawn between the government of England and that of our several states. Our commonwealths, or the proper representatives of such of them as have taken action, approve or amend plans for sewage disposal works in accordance with local conditions. Our state authorities have no set rules which they apply everywhere with an iron hand, like the present rule of the Local Government Board that all sewage of combined systems, up to three times the dry-weather flow, must have full treatment and an additional volume up to six times the dry-weather flow partial treatment on special areas.

The nearest approach to the arbitrariness of the Local Government Board is by the Massachusetts State Board of Health. While it has never promulgated set rules and has always given a large measure of consideration to local conditions, when passing on plans submitted to it, yet by one means or another it has virtually barred out of the State the newer methods of sewage treatment and the mechanical filtration of water. It was largely due to the more direct and specific but scarcely less arbitrary action of the Local Government Board in not accepting the newer methods of sewage treatment as a substitute or partial substitute for land treatment that the Royal Commission on Sewage Disposal was created. But we hasten to notice an immense difference between these two central authorities: The stand of the Local Government Board on this and other matters has been of the bureaucratic and circumlocution-office type, while the Massachusetts State Board of Health has for twenty years required the adoption of no method of sewage or water purification which it has not itself found, after extended investigation, to give high-grade scientific results. The Massachusetts Board, more particularly as regards sewage, has conducted elaborate studies of the newer methods of purification (avoiding only or chiefly patented or proprietary processes). The chief criticism that can be brought against it, perhaps, is that it has been ultra-conservative as to the newer methods, but even in this it has had the justification that geologic and other conditions in Massachusetts are particularly favorable to what for this discussion may be termed the slow-sand filtration of both sewage and water. And yet after all that can be said in support of the attitude of the Massachusetts State Board of Health many will believe that it has done much to stifle originality and progress in both water and sewage purification within its jurisdiction, except as both those qualities have been developed under its own direction at the Lawrence Experiment Station.

This throttling of originality is the great danger in all central supervisory control, either by municipalities or private corporations. It is far from being a sufficient argument against central control, but it is one that must be reckoned with and guarded against.

In the few cases where the arbitration of disputes between capital and labor has been offered by the United States federal government it has been the action of a high official who, from the nature of his office, held such a position in the community that he could command the respect of both sides of the quarrel. Though not illegal it was not specially authorized by any law; indeed, the constitutional limitations of federal jurisdiction throw grave doubts on the possibility of such a law. In some of the states, however, boards of arbitration have been constituted with powers to offer their services as mediators in labor disputes. In England this matter of official arbitration has gone even further. There, under a law known as the Conciliation Act of 1896, the Board of Trade was given power in trade disputes to appoint a conciliator and, at the request of both parties, to select an arbitrator to settle the misunderstanding. Under this law the results have been very gratifying. In 1905, the Board of Trade intervened in 14 cases and settled them all; in 1906, it intervened in 20 cases and settled 16, and in 1907 it adjusted 32 out of the 39 disputes in which it was called. Up to September of this year 35 out of 47 cases had been settled, and some of the remainder are still under advisement.

Satisfactory as the workings of the law have been, the President of the Board of Trade, Mr. Winston Churchill, has recently issued an order changing the system of arbitration to some degree, in the hope that the new method will overcome the minor difficulties of the past. Under this new scheme the single arbitrator is to be supplanted by a standing Court of Arbitration, the make-up of which is described in the governmental memorandum as follows:

> The Court, which will sit whenever required, will be composed of three (or five) members, according to the wishes of the parties, with fees and expenses to members of the Court, and to the chairman during sittings. The Court will be nominated by the Board of Trade from three panels. The first panel—of chairmen—will comprise persons of eminence and impartiality. The second will be formed of persons who, while preserving an impartial mind in regard to the particular dispute, are, nevertheless, drawn from the "employer class." The third panel will be formed of persons similarly drawn from the class or workmen and trade unionists. It is hoped that this composition will remove from the Court the reproach which workmen have sometimes brought against individual conciliators and arbitrators that, however fair they mean to be, they do not intimately understand the position of the manual laborer. It is believed that by the appointment of two arbitrators selected from the employers' panel and two from the workmen's panel in difficult cases, thus constituting a Court of five instead of three persons, the decisions of the Court would be rendered more authoritative, especially to the workmen, who, according to the information of the Board of Trade, are more ready to submit to the judgment of two of their representatives than of one. As the personnel of the Court would be constantly varied, there would be no danger of the Court itself becoming unpopular with either class in consequence of any particular decision; there would be no difficulty in choosing members quite unconnected with the case in dispute, and no inconvenient labor would be imposed upon any one who consented to serve on the panels. Lastly, in order that the peculiar conditions of any trade may be fully explained to the Court, technical assessors may be appointed by the Board of Trade at the request of the Court or of the parties to assist in the deliberations, but without any right to vote.

About a year ago we noted a praiseworthy agreement between associations of English manufacturers and workmen, in which special provision was made for arbitration in case of any radical disagreement in policy or principle. With the impartial, or at least evenly balanced, court provided by the latest order of the Board of Trade this apparent intention of both capital and labor to adjust their differences fairly has been greatly aided. There may prove difficulties in the detail of appointments and administration of the Court, but its future progress will be worth watching.

The construction of a hundred reservoirs to prevent floods, aid navigation and create water power on the Ohio River and its tributaries was discussed at length in a recent paper by Mr. M. O. Leighton, Chief Hydrographer of the U. S. Geological Survey, reprinted in our issue of May 7, 1908. Several communications criticizing Mr. Leighton's paper have already been received and published in our columns, and in the present number we present to our readers the most valuable discussion of the paper which we have yet received, the author being Major H. C. Newcomer, Corps of Engineers, U. S. A.

There has been considerable delay in preparing Major Newcomer's paper for publication, and by chance this delay makes it possible to present in the same issue a review of the history, present status and prospects of the improvement of the Ohio River for navigation purposes, which has been chiefly by providing dams and locks or slack-water navigation.

A careful reading of the articles, which we publish side by side and a re-reading of Mr. Leighton's paper, it seems to us, will suggest several lines of thought to any of our readers interested in the best possible means of conservation and utilization of the great river systems of the United States. The chief object of Mr. Leighton's paper was to arouse just such critical analysis and further investigation of its subject matter as Major Newcomer presents elsewhere in this issue. Mr. Leighton's main thesis was that the possibilities of extensive water storage on the headwaters of our great rivers (using the Ohio for specific illustration)

are worthy of serious consideration as possible means of flood prevention and aids to navigation. Major Newcomer admits this, at least to the extent of discussing some of Mr. Leighton's arguments at length and of having somewhat detailed studies and estimates made of storage costs in the Ohio drainage basin. But in both his *a priori* arguments and in his conclusions drawn from special studies, Major Newcomer is as much against storage as Mr. Leighton was in favor of it, particularly storage to benefit navigation.

Major Newcomer makes a strong presentation of the difficulties that stand in the way of reservoir river control, particularly the cost obstacle, but we think his arguments increase rather than decrease the force of Mr. Leighton's thesis for a thorough-going study of the whole subject.

What we should like to impress on our readers is the need for the broadest possible consideration of everything pertaining to the water resources of each of the great drainage systems of the United States, beginning with those presenting the most urgent problems, but keeping constantly in mind the best possible means of conserving and utilizing to their utmost *all* the water resources of the country, as rapidly as needed.

River improvement and utilization has or should now become more than a mere matter of dredging, levee building and dam building, in the interests of navigation or navigation and flood protection. Other possibilities of river-flow control ought to be given full and fair consideration, and other ways of utilizing water than in moving boats should receive such attention as the peculiar needs and possibilities of each stream demands.

That the broader views of river improvement and control disclose physical, financial and governmental difficulties is no reason for throwing up the hands. No, not if the full utilization and control of our natural waters should finally demand, as it bids fair to do, either a combination or the cooperation of national, state and municipal agencies.

That some change is demanded to serve the needs of navigation alone is evident from the little progress that has been made on the Ohio River improvements in the eighty years' work which is reviewed in the article that follows Major Newcomer's contribution in this issue. In nearly a century of time, the friends of Ohio River navigation have wrung from Congress and there has been expended only some $10,600,000, while $63,000,000 is estimated as necessary to secure 9 ft. of water from Pittsburg to the mouth of the Ohio. Of the $10,600,000 expended up to June 30, 1907, $3,900,000 was for the canal and accessories at the Falls of the Ohio.

Does any one doubt but that more money might have been secured in the past and far more in the future if, instead of navigation alone, there was placed before Congress and the legislatures of the Ohio Valley states, the municipal governments of Pittsburg, Louisville, Cincinnati, etc., and before their respective constituents, a well-considered plan of water storage, power development, flood prevention and navigation improvement? We are well aware of the difficulties involved in such a comprehensive scheme for either the Ohio or any other of our great river basins, but no difficulty has yet been suggested that seems formidable enough to warrant vetoing the careful and comprehensive studies advocated by Mr. Leighton.

THE STATUS OF THE IRON-SLAG BLOCK FOR STREET PAVING PURPOSES.

The iron-slag block for street-paving has had small notice in the literature of the subject and except for a half-dozen cities in this country and in Canada, where it has been used in the past to a considerable extent, it is generally unknown or unfamiliar to the municipal engineers on this side of the ocean. In the last few months, however, in one at least of the large cities, there has been displayed a renewed interest in the material which warrants an investigation of its virtues and defects for the large portion of the profession which is unacquainted with its properties. From such an investigation, particularly from such discussions of the behavior of the block as recounted by various engineers on another page of this issue, to what extent is the engineer, to whom this block is a novelty, justified in specifying it?

In reading these accounts from the various cities it should be recognized that any new material must be greatly superior to the one in use in order to overcome the prejudices in favor of the latter. That it is just as good will not serve. In this respect the iron-slag block fails. In most of the cities where it has been used in the past its advantages were not so marked as to make it a very pronounced rival of the granite and brick which it is intended to supersede, or at least to alternate with; as a rule, its use has not so impressed the engineers who have had experience with it that they continue to specify it in their work.

Taking up now the virtues and defects as noted in the reports. The praise of its good qualities is very faint, although it is evident that it has many of the advantages of the clay paving-brick. It is hard and fairly durable, non-absorbent and easy to clean; when properly laid it has an even surface, thus promoting ease of traction; it can be laid on all grades and there is little dust or mud from it. On the other hand, it has many deficiencies not so evident in brick paving. It soon acquires a very slippery surface, it is hard to lay on account of the inequalities in shape and size, it has a marked tendency to flake on the surface, leaving an unsightly and unsafe street and the possibility of interior blow-holes suggests a weak spot in the wearing plane. The noise-deadening properties, being largely a matter of base and joints, are subject to argument. These are all matters of observation in service, the best criterion by which worth can be judged. But for complete information as to its comparative wearing qualities laboratory tests are likewise useful, and of these the iron-slag block has none. Those who advocate its use would do well to institute such tests according to the same methods in vogue for other paving block so that some comparison can be made and so that the now absent basis for specification can be had.

All of the above points for and against the block are purely physical, but quite as important in the opposition to it is the present status of its manufacture. Not only is it the product of a foreign country, thus prefining an increased cost due to the import duties and difficulties in shipment, but it is practically a monopoly product of one firm. Some years ago the blocks were made in this country, but the factory has long since gone out of business; on the continent of Europe there are said to be several firms engaged in this business, but they are not equipped for export deliveries. To-day the production is so localized that contractors who require a considerable number of these blocks for paving purposes, after instituting extensive searches throughout this country and abroad for the material, find that the consolidated English firms are the only ones in the market and that blocks bought from them have to be procured through one agency in this country, which controls the price and delivery. Such a condition is discouraging to private specifying of the block, and in governmental work, even when such specification does not violate the usual anti-monopoly clauses in the city charter, it subjects the city engineers to unpleasant charges or suggestions. Until the American blast furnaces see their way clear to manufacture the iron-slag block, a procedure that would seem well worthy their serious study, the average engineer will probably not devote much of his energy toward investigating its properties.

Meanwhile, from the available reports, it will be noticed that a considerable amount of the paving laid with these blocks has been in the space between and adjoining railway tracks which the street railway company is usually required to lay and to maintain. This space is usually subjected to very heavy travel, especially when the street is narrow and the paving exterior to the tracks is poor asphalt or rough blocks, as in Baltimore. It is admitted that the iron-slag block is very hard and du[illegible] so that it acts admirably under the heav[illegible]affic and the difficulties in laying, the slipper[illegible] and the surface flaking become secondary [illegible]e necessity for a hard base. It is here, [illegible] that the future possibilities of the block [illegible]em most bright.

In connection with the investig[illegible] of the block noted on another page, an [illegible]repeated plea in these columns is recal[illegible]the appeal for definite specifications. Th[illegible]rtion of the specification printed in the art[illegible]s a particularly brilliant example of the ind[illegible]te wording that may be the cause of much [illegible]ble between the contractor and engineer an[illegible]e object of suspicious criticism by the muck[illegible]r. For glittering generalities it is a model. [illegible] is conceivable that a product may reach su[illegible] a standard that it can be specified by nam[illegible]ply, but even in the most standardized mater[illegible] this is not done. How much less should it [illegible]done in the case of the iron-slag block, con[illegible]ng the qua'ities and behavior of which so little is known. Under the specifications as written, a pressed iron-slag block might pass a complacent engineer, and certainly the weaker block possible with the high silica slags of Pennsylvania would have to be accepted. The probable excuse for the specification is that but little is known of the qualities of the block, but before installing some hundreds of thousands of them it seems only reasonable that the engineers make some effort to discover and outline the qualities that are desirable. A monopoly product specified by name only certainly should arouse suspicion.

LETTERS TO THE EDITOR.

Effect of Tile Drainage of Adjacent Land on Flashy Streams.

Sir: Referring to the description of field methods used in the "Topographic Mapping of Bottom Lands in Illinois," in your paper under date of Sept. 24, p. 333, I beg to take exception to the undue prominence that is given to tile-draining as a factor in the flashy features of Illinois streams. The popular impression is that all tiling has a tendency to rush the water into the large waterways at a constantly increasing rate. While there doubtless are cases where complete tile drainage increased the flow of streams during flood season, there are certain features pertaining to lands which have been thoroughly drained to a depth of several feet which tend to regulate the supply of water flowing into our rivers.

The writer has in mind a certain 50-acre tract which was tiled about 25 years ago. Before tiling, the tract was too wet for cultivation except in very dry years, though there was practically no flow from this tract (into the stream which ran along one edge) during the larger part of the year. Since the tile was placed, the flow has ceased only three or four times during seasons of extreme drought and that for only a few weeks at most. The thorough subdrainage given by this tile makes available a considerable storage reservoir into which immense quantities of water are absorbed before excessive surface flow takes place.

The flashy condition of streams fed by tiled lands follows in each instance after the placing of tile, but it is very probable that the principal cause is to be found in the changed surface conditions rather than in the subdrainage.

The necessity of thorough exploration by lines run at frequent intervals, as emphasized by the article referred to, is of especial importance in river bottom surveys, and there is nothing (less than a Louisiana cane brake) which is more discouraging to the field party than getting a line through jungles of willow "horse" weeds, drift and other miscellaneous bric-a-brac found in our Illinois river bottoms. The inability of the average topographer, or even an experienced chief-of-party, to keep a well-balanced impression of distances and proportions when working in such country makes it necessary to run lines at frequent intervals in order to insure against missing topographic features of importance.

Yours very truly, A. M. Shaw,
Assoc. M. Am. Soc. C. E.

Dixon, Ill., Sept. 25, 1908.

British and American Macadam Roads.

Sir: I have read with interest the article in your last issue on the comparative wearing qualities of English and American macadam roads.

Your correspondent has apparently failed to give any credit to the broad tires which are used on all classes of vehicles in England and which are undoubtedly much

less severe on the wearing surface than the narrow tires used in this country.

Although signs are posted on all New York state roads, recommending the use of broad tires, there has not been, as far as I have been able to notice, any increase as yet in the width of tires. It is obvious that the public will not purchase vehicles with broad tires at increased cost unless laws are enacted and rigidly enforced limiting the weight to be carried on tire per unit of width.

It would be interesting to have your correspondent advise us as to what proportion of the English roads are built of telford as compared with macadam. Is it not possible that the better wearing qualities of their roads are due to the fact that they are built of telford? The large stones which compose the foundation of a telford road, form a permanent foundation which cannot be disturbed, while the small stones which form the foundation course of macadam roads in this country are soon forced down into the underlying soil, particularly in the ruts and in sandy soil such as is found in the neighborhood where I have had occasion to observe state roads which have been built but a short time, but which are already badly rutted. It is very much to be regretted that now that this country has entered upon an era of road building, that the class of work which is now being done, in this state at least, is second or third rate when compared with the magnificent roads which are to be found in such a poor country as Norway.

We can well afford the best type of construction, but we have apparently yet to learn by our own experience, that it is the cheapest in the end.

Very truly yours,

Howard W. Starr.

11 Front St., Schenectady, N. Y., Sept. 30, 1908.

Colloidal Clay for Waterproofing Concrete.

Sir: I have read with interest the results you publish in the issue of Oct. 1, 1908, p. 373, of a series of tests by Mr. H. W. McGee, Engineer of Maintenance of Way of the Ulster & Delaware Ry., to determine the waterproofing value of alum and clay as ingredients of concrete. Without desire to comment on these experiments, it is necessary that attention be called to an error in the original paper on "Waterproofing Concrete," communicated by me to the American Society of Civil Engineers, July 30, 1907, and published in Engineering News, Sept. 26, 1907, p. 344. In the hurried preparation of the paper as a portion of discussion for the Transactions of the Society, it was stated that watertight concrete may be obtained by "replacing from 5 to 10% of the *cement* with an equal quantity of dried and finely ground colloidal clay, intimately mixed with the cement." Instead of this, I meant to state that watertight concrete could be obtained by replacing from 5 to 10% by weight of *sand* with an equal quantity of finely ground colloidal clay, intimately mixed with the cement. While Mr. McGee's tests throw some light on the effect of replacing cement with clay, his results cannot be considered as comparable with ours, since in the experiments conducted here, given proportions of *sand* alone were replaced by clay.

Recent laboratory tests here with properly selected and prepared clay have fully confirmed our published results of a year ago, with uniformly increased strength and practical impermeability under ordinary pressures, both in mortars and concretes. In fact, apart from the waterproofing effect, the increases in tensile and compressive strengths have been such as to apparently justify the recommendation of additions of clay for strength alone.

Continued experiments with alum and other salt solutions have given results that were variable and inconclusive.

Yours very truly,

Richard H. Gaines,

Chemist, Board of Water Supply, City of New York.

New York, Oct. 1, 1908.

Stress-Calculation in Reinforced-Concrete Chimneys.

Sir—In your issue of Sept. 10, 1908, Prof. E. R. Maurer gives a method of designing reinforced-concrete chimneys in which there appears to be an error.

Near the bottom of the first column on page 276 the value of I for a cylindrical steel shell of radius r is given as one-fourth of the area by the square of the radius. This should be one-half of the area by the square of the radius. This factor ¼ occurs again in the formula just below and is used in the numerical example, so that it does not appear to be a typographical error. It might be said in extenuation that in the numerical example the result is affected only about 2% by this error. I have not traced its effect in the diagram for steel areas. It is a good reason for neglecting entirely this fictitious thin cylinder of equivalent concrete area, represented by the steel reinforcement, in finding the stress on the concrete, that an error of 50% in that portion of the formula scarcely affects the results. There is another and a more potent reason that I shall mention presently.

Prof. Maurer says of Case 2, where there would be tension on the concrete, "Practical rational formulas for unit stresses for this case cannot be deduced." I take issue with him in this. It is both practical and rational to find the moment of stability of the plain concrete chimney, assumed to take no tension, and then add a ring of reinforcing rods that will take the surplus of wind moment over and above this moment of stability. Furthermore, the mathematical work is extremely simple. This is the method published by me in "Concrete Engineering" in 1907 and reprinted in my book "Concrete."

Absolute accuracy of stress determinations in reinforced concrete is neither possible nor desirable, and intricate mathematical processes do not spell either safety or certainty. The poor practical designer has a right to be considered; and a complex formula or diagram, the derivation of which he may not understand, is apt to be the source of far more errors in actual designs than a formula that on the face of it is approximate (and thus in entire accord with knowledge of stresses in the premises), but whose derivation is simple and direct and easily checked.

Prof. Maurer has used a very high compressive unit on concrete, namely, 500 lbs. per sq. in. This would not be high for short blocks, or for hooped columns, or as extreme fiber stress on reinforced-concrete beams where the compression is on one side only. But some recent column failures where the unit was found to be not much over this (in columns with longitudinal rods embedded in them) ought to serve as a warning against the use of any such units. The use of longitudinal rods in compression members, according to tests made at the Illinois Experiment Station, may *reduce the ultimate strength below the plain concrete member by nearly one-quarter.* This is a small fact of enormous importance, and it has been almost totally overlooked by engineers and book writers. It is neither correct nor economical to use rods in compression in concrete.

As I have pointed out before, theoretical, or so-called rational methods of locating the neutral axis of reinforced-concrete members can have absolutely no value so long as they ignore the effect of the shrinkage of concrete, and attempts to make theoretical allowance for this shrinkage would be worse than useless. Direct measurement shows that in beams the neutral axis is close to the middle of the depth of concrete. Why not assume its location at the middle in all cases until tests prove it to be located elsewhere?

Yours very truly,

Edward Godfrey.

Monongahela Bank Building, Pittsburg, Pa., Sept. 11, 1908.

Sir: In reply to the communication from Mr. Godfrey regarding my recent article on "Wind Stresses in Reinforced Concrete Chimneys," I wish to state:

An error exists in the article as pointed out by Mr. Godfrey, and I thank him for his notice of it. Contrary to his surmise, the error does not affect the diagram (Fig. 3), which is the important feature, nor anything else in Case 2.

The fact that in Example 1 a 50% change in amount of steel affects the result by only 2% merely suggests that *in similar circumstances* (in upper sections of a chimney) the stress in the concrete is not affected much by the steel, and that the stress may be satisfactorily computed by leaving the steel out of account. One who has computed a few chimneys knows that upper sections need not be investigated for stress and that the main function of the vertical steel there is to prevent cracks in the concrete which might arise from causes other than wind pressure. Why then did I present formulas for upper sections? For the inexperienced—to make the discussion cover all cases for him. I hoped that the experienced would find practical interest in the diagram.

I have examined Mr. Godfrey's method for determining the tension in the steel and the compression in the concrete, but am not convinced that it should be described as rational. As I read and reread his explanation, all the assumptions made did not seem reasonable, the joint effect of the approximations involved was not apparent and each time, when I reached the end, I wondered "where I was at." Now the derivation of a rational formula does not leave one in that frame of mind, I think. Here is one peculiar phase of his method. In an example, he determines, with a working stress of 12,500 lbs. per sq. in., that 31 ⅞-in. rods are required to reinforce the base section of the chimney of given dimensions for an assumed wind pressure, and then he computes the greatest unit compression at the section to be 313 lbs. per sq. in. for that same wind pressure. Had he used 10,000 for the steel, the number of rods would have been 39, but the compression in the concrete would still have been 313. In other words, the greatest unit-stress in the concrete at any section does not depend on the amount of steel there, provided only that the amount is deemed sufficient; any excess has no effect on the concrete stress. This idea does not appeal to me as a rational one.

I wish to modify the claim that my diagram is rational, for, strictly speaking, it is not. It is based on assumptions known to be approximations. But, inasmuch as the diagram is derived logically from very widely accepted assumptions concerning reinforced-concrete beams, I was led to call the diagram rational, and I intended to convey the idea that practical formulas for the stresses in steel and concrete could not be derived logically from these same assumptions.

The question of importance to those interested in the design of reinforced-concrete chimneys is not, after all, whether either of the methods under consideration is strictly rational, but which is the more valid if they disagree materially—and they do so disagree. For instance, in Example 3 of my article, it is found that the unit-stresses in the concrete and steel are respectively 399 and 7,600, whereas Mr. Godfrey's method gives 351 and 12,500; and in Example 4 my diagram shows that 1.9% of steel is sufficient to keep the concrete stress within the specified limit (500), whereas Mr. Godfrey's method shows that no amount of steel will keep the concrete stress down to this limit and that it cannot be made less than 560. For any given reinforced chimney section, given superincumbent weight and given wind moment, Mr. Godfrey's method gives a higher stress in the tensile steel than mine, and the difference may be large; it gives the concrete stresses higher in some cases and lower in some, than mine, and the differences may be large.

As already stated, my diagram is based on assumptions involved in the most widely used theory of flexure for reinforced concrete. These are essentially: that practically, for working loads, plane sections of a beam remain plane during bending; that there is a constant modulus of elasticity for concrete in compression; that there is no tension in the concrete near sections of maximum moment; and that steel and concrete work together, that is, adhere perfectly.

While the derivation of my diagram may be described as complex, I do not believe that the diagram itself is so, as claimed. I know of no scheme that yields a solution of the problem under consideration as readily as it does.

My use of 500 lbs. per sq. in. for concrete should not be construed as recommending this figure as a working stress for indiscriminate use. I believe it a safe value for first-class work and concrete. Supposing it to be generally true that embedded steel reduces the ultimate compressive strength of concrete 25%, as it appears to have done in a single one of the accepted tests referred to (the average reduction was 16%) even then an ample margin of safety may be provided (by the use of good concrete and work), the working stress being that criticized. It is worth noting here that Mr. Sanford E. Thompson in his report on "Failures of Reinforced-Concrete Chimneys"* suggests a working stress of 600 lbs. per sq. in. for concrete whose ultimate strength at 28 days reaches 2,500.

Of course embedded steel cannot be worked so effectively in compression as in tension, but that is no reason for neglecting entirely the stress in compressive steel as Mr. Godfrey does in his method. In the Illinois tests, Talbot states that per unit area the steel took about 13 times as much load as the concrete at the small loads and about 26 times as much at the ultimate. I used 15 as the ratio for all working stresses in the construction of my diagram.

I do not feel it incumbent on me to defend the common theory (as I would call it) for locating the neutral axis, the theory being so widely accepted. I may state, however, that direct measurements for locating the neutral axis, as they have been made, do not controvert the theory. These measurements merely locate the average position of the neutral axis for the gage length; where the incipient crack is, there the axis is higher. To be sure, the actual neutral axis is close to the middle of the beam as claimed, but it is also close to the theoretical axis, and generally closer, I believe. My space and time do not permit a full comparison of these two small distances drawn from actual tests.

One series of tests, however, I have at hand, and it bears all the ear-marks of being reliable; it is reported in Mörsch, pp. 102 et seq. (3d ed.). The series consisted of 9 beams, 3 with 0.4%, 3 with 1.0% and 3 with 1.9% of steel. Mörsch averaged the measurements for each set of three beams and pictures the positions of the average neutral axis for various stages of loading. At the load producing first cracks, the average neutral axis is, in each set, between the middle of the beam and the theoretical axis but nearer the latter. Calling the distance between the mid-axis and the theoretical axis 100, then the distances from the determined average neutral axis to the others are, respectively, as follows (at the load mentioned):

73 and 27 for the 0.4% set,
85 and 15 for the 1.0% set, and
60 and 40 for the 1.9% set.

In the last set the distance called 100 is itself small compared to the depth of the beam, and the figures 60 and 40 may be in error 5 or 10 units.

Yours truly,

E. R. Maurer.

Madison, Wis., Oct. 3, 1908.

*For abstract see Eng. News, Jan. 9, 1908.

Stream Motors in the Mississippi.

Sir: In looking through Vol. 49 of Engineering News a few days ago, I came across the letter by Col. Sylvester Stewart on cheap power from river, in which he advocated the current motor and especially the screw in a current motor as superior to floats or paddles in deriving power from a flowing stream. Col. Stewart, in his article, speaks of Memphis as a good place for the use of such a power system.

To-day, in the "Atlantic Monthly" for September, 1908, page 381, I found, in an article on the Mississippi River, some figures as to the velocity of the Mississippi near Helena, Ark., at high and low water, that make it possible to estimate the total power of the river according to the formulas in the editorial note in the issue with Col. Stewart's article. Thinking they might be of interest I have taken the trouble to send you the result of calculations on those data.

The article on the Mississippi River gives the velocity at low water as 2.19 ft. per sec., the gage being 1.5 ft. and the area of the cross-section 51,100 sq. ft.; also the velocity at high water 6.71 ft. per sec., gage 50.4 ft., cross-section 210,000 sq. ft.

Now, by the rule in the editorial note mentioned, the theoretical HP. per sq. ft. of the flowing water is

$$HP. = 0.0018\ v^3$$

where v is the velocity in ft. per sec.

For a velocity of 2.19 this would be 0.0189 HP. per sq. ft. and for the whole cross-section of the stream at this stage, 51,100 sq. ft., the theoretical figure would be 965 HP. Similarly, for a velocity of 6.71 the theoretical power would be 114,000 HP. In neither case would it be practicable to use every square foot of area of cross-section of the river, and even if it were the above figures should each be divided by three to allow for the low efficiency attainable, giving 322 HP. and 38,000 HP., respectively, for the whole power of the stream at high water and low water.

But, as some approach to practicability, suppose it is possible to build and put to work 100 wheels each of 30-ft. diameter, and suppose we take the mean of the two velocities given, which is 4.45, as the velocity for the average stage of the river, let us see what power that would yield. From the difference of the cross-sectional areas 158,900 sq. ft. and the difference of the gage readings 48.9 ft. we see that the average width of cross-section is 3,250 ft., so that the 100 wheels 30 ft. in diameter would fill the space from bank to bank, with a little for clearance. If the channel be assumed rectangular the width, 3,250 ft., divided into the low water area would give the depth, 15.7 ft., at low water, or 64.6 ft. at high water, the average of which is 40.1 ft. So at half-way between high and low water the wheels of 30-ft. diameter would lack 10 ft. of touching the bottom.

These 100 wheels 30 ft. in diameter would have an area of 70,600 sq. ft. and each sq. ft. at a velocity of 4.45 ft. per sec. would develop 0.159 HP., theoretically, or 11,200 HP. for all the wheels which at an efficiency of ⅛ would give, say, 4,000 HP.

Now, if 4,000 HP. could be so derived, would it pay to develop it? Each wheel would at this rate yield 40 HP. and that at $20 per HP. per year (power for 24 hrs. per day) would be worth $800 per year. This is 4% interest on $20,000, so if each wheel could be put in for less than $20,000 it would pay if the scheme proved operatively successful.

Would 4,000 HP. be a large amount of power to develop at one point? It would be if a number of these plants could be placed on the river at intervals of a few miles, as Col. Stewart suggests. Compared to modern electric power houses, 4,000 HP. is not very large, for in Memphis at this day the power supply house doubtless has a capacity several times this. But 4,000 HP. is not a trifle if it could be developed by this method.

Respectfully, John Wilkes.
Civil Engineer.

2 Berry Block, Nashville, Tenn., Sept. 5, 1908.

[Our correspondent seems to forget that in developing for average water level instead of low, in times of low water the screws will be half out of the water and of little use. It would seem that advance in stream motors could, at present, be assisted best by having inventions such as the Stewart motor examined and tested by well-known hydraulic engineers. Surely on the strength of such reports, if favorable, a service trial could be made. No little trouble may be expected in anchoring the motor without interfering with the stream and in transmitting the power to shore.—Ed.]

Notes and Queries.

In the article, in our issue of Sept. 24, describing the collapse of the B. & O. R. R. bridge across the Susquehanna River, we said that the first bridge at this point was a Howe truss structure built some time before 1850. This statement was in error. The Howe truss bridge referred to was on the line of the Pennsylvania R. R., about one mile down-stream. The first B. & O. bridge was the series of iron trusses built in 1884-85. The traveler on the present reconstruction weighed 300,000 lbs., not 300 tons as stated.

A LARGE STEEL-PILE COFFERDAM FOR A SHIP LOCK AT BUFFALO N. Y.

In connection with the improvements to the harbor of Buffalo, N. Y., a large ship lock is being built under the direction of the U. S. Engineer Corps. This lock is in Black Rock Harbor, which is the name given to the side channel of the Niagara River between Squaw Island and the main shore. The lock will be of concrete, 70 ft. wide in the clear inside, and 817 ft. long over all. As the site is in water from 3 to 15 ft. deep, it is being enclosed by a cofferdam which is carried up 5 ft. above the water level. This cofferdam is 947 ft. long, 260 ft. wide at one end and 245 ft. at the other. The change of width is made in order to maintain a 50-ft. channel between the cofferdam and the harbor line. The plan and section in Fig. 1 show very clearly the arrangement of the cofferdam and the lock.

The construction of the cofferdam is of interest owing to the use of steel piling throughout, this piling being of a pattern used here for the first time. For each wall there are two lines of piling 30 ft. apart. These are connected at intervals by transverse bulkheads which form pockets 30 × 30 ft. The piling is driven through sand, gravel and clay to bed rock. The material within the pockets is not removed, but as soon as each pocket is completed it is filled with clay. When the cofferdam is completed, the enclosed area will be excavated for the construction of the lock.

It will be seen by the cross-section that a toe of undisturbed material will be left along each side. Above this, the inner row of sheet piling is supported only by the transverse bulkheads which tie it to the outer row at 30 ft. intervals. For such an arrangement it was necessary that the interlocked joints of the steel piles should combine flexibility and strength; the former to allow of properly closing each pocket and the latter to hold the inner row of piling in position. It was therefore decided to conduct a series of experiments with various forms of steel sheet piling, and a new type of pile produced recently by the Lackawanna Steel Co., of Buffalo and New York, was found to best meet the requirements. This pile is described farther below.

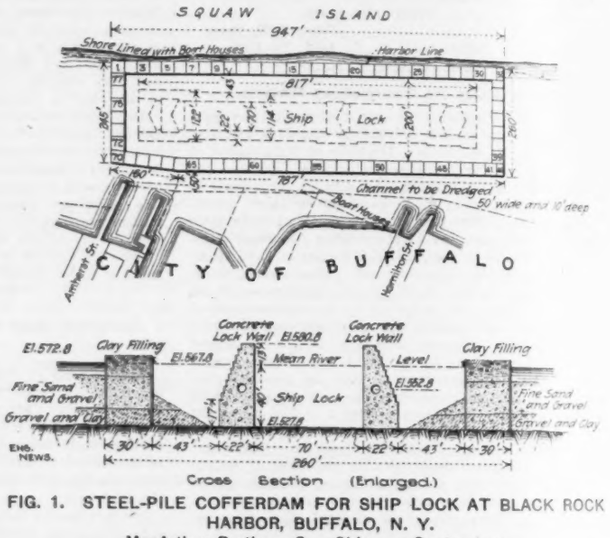


FIG. 1. STEEL-PILE COFFERDAM FOR SHIP LOCK AT BLACK ROCK HARBOR, BUFFALO, N. Y.
MacArthur Brothers Co., Chicago, Contractors.

As used in the cofferdam, the sheet-piles are from 41 ft. to 50 ft. long. The water is from 3 ft. to 15 ft. deep, and the piles are driven through an average of 30 ft. of fine sand, clay, gravel and hardpan, with occasional boulders. The average depth to rock is 40.7 ft. The driving is done by two floating pile drivers, with Vulcan steam hammers. The leaders are 52 ft. long, and reach to within 8 ft. of the water. Each driver is mounted on a barge 20 × 50 ft., and is equipped with a double-drum, double-cylinder hoisting engine (8¼ × 10 ins.), a jetting pump 9 × 5½ × 10 ins., and an 11-in. air pump. One machine has a 5-ton hammer and the other a 3¼-ton hammer.

Both pile drivers make very favorable progress on the work, although the smaller hammer drives more piles than the other, and with better results. With both machines working 8-hour shifts, the average work is 450 piles per week. No difficulty is experienced in closing the pockets, as a "spacer" (which is a short pile) is driven on each side of the last corner driven. After the corner pile has been driven home, the two spacers are removed and regular piles driven in their places. Fig. 2 is a view taken from one of the pile drivers and showing the east wall of the cofferdam.

The MacArthur Brothers Co., of Chicago, has the contract for the lock, and is now at work on the cofferdam. Mr. J. N. Beisel is their superintendent on the work. The contract for driving the sheet-piling has been let to the J. E. Horton Construction Co., of Buffalo, N. Y.

THE LACKAWANNA STEEL CO. SHEET PILING.

The steel sheet piles used for this cofferdam are a new product, having been put on the market only during the current year. They are integral rolled sections, without rivets or other assemblage to form the interlock, and the edges are so shaped that a complete hinge joint is formed between adjacent piles. This joint has an arc of motion of 44° (22° to either side), which means that a right angle could be turned in the course of four successive piles. This satisfactory degree of flexibility is coupled with a relatively high resistance to pulling apart. The manufacturers report that a series of tests on their 12¾-in. piling showed the average tensile resistance of the joint to be 9,700 lbs. per lin. in.

As shown by Fig. 3, the pile may be described as an I-beam whose flanges are bent away from the web to form something more than a semi-circumference, one horn of the crescent, however, being thickened into a heavy hooklike section. This hook is engaged by the hook of the adjoining pile, while the other horn of the crescent extends around the back of the hook and holds it in engagement. The joint can be disengaged only by withdrawing one pile longitudinally. The contact surface in the joint, however, is limited to three points (or lines), so that there is a minimum of friction in driving or withdrawing.

The two flanges of the pile have their hook sections on the same side of the web. In a line of piling, therefore, alternate piles will have the hook side facing in while the intermediate ones have the hook side in.

These piles are rolled at present in widths of 12¾ ins. and 7 ins., the former width being made in two thicknesses. The following are the dimensions and weights:

Width c. to c. joint.	Weight. Lbs. per lin. ft.	Weight. Lbs. per sq. ft. of wall.	Web Thickness, ins.	Joint Thickness, In.
12¾	42.5	40.0	½	2 13/16
12¾	37.187	35.0	⅜	3 5/16
7	11.5	19.7	¼	1 5/16

They are rolled in 60-ft. lengths, but may, of course, be furnished cut to any desired length less than this.

Special piles are made for turning sharp corners

ners and for joining a wall at right angles to the middle of another. These are illustrated in our drawing. As there shown, the corner section consists of two halves of the ordinary pile, joined by a steel angle to which the two webs are riveted. The T-sections are made in a similar way, a half section being riveted at right angles to the face of a full section by two steel angles. In addition, tapered sections for easier adjustment in curving lines of piling are made up as stock material. These are 20¾ ins. wide at the top and 12½ ins. wide at the bottom. They are made

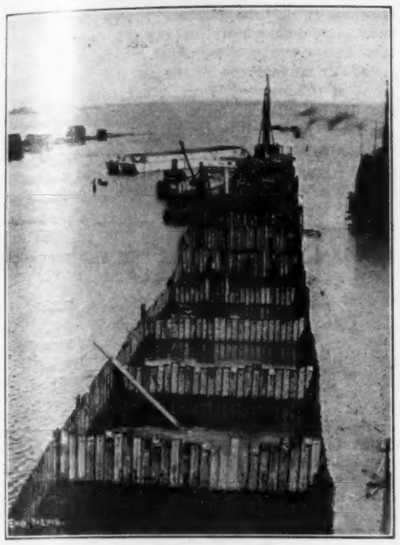


Fig. 2. Portion of the East Wall of the Steel-Pile Cofferdam for Ship Lock at Buffalo, N. Y.

by slitting a section lengthwise into two halves and riveting them to a tapered plate running full length of the pile.

Making the joints of these piles watertight is said to offer no special difficulty. In an experimental cofferdam which was put down before the new form of piling was placed on the market, it was found that the soil worked into the joints during driving sufficiently to make the cofferdam practically watertight. Where the piles are driven in water, or where complete tightness is not secured at first, any method of packing may be used to make the joints tight, the form of the joint affording ample room for this purpose.

In the large cofferdam for the Buffalo ship lock, described above, there are about 6,870 lin. ft. of piling, and the piles are 44 to 50 ft. long. The total weight of the piling approximates 7,000 tons.

CONCLUSIONS AND RECOMMENDATIONS OF THE FIFTH REPORT OF THE BRITISH ROYAL COMMISSION ON SEWAGE DISPOSAL.

Ten years ago the late Queen Victoria created a Royal Commission on Sewage Disposal, thus adding another to the various commissions of similar name and object that had been brought into existence during the half century of her reign. No little impatience has been expressed, as the years have passed, because the Commission did not make a final and conclusive report. Four interim reports were issued in the six years up to 1904 and now, after four more years another report,* still not final, has appeared. But while the present report is not final it contains a number of quite specific conclusions and recommendations. Some of these are given herewith, and for them we are indebted to our London contemporary, "The Surveyor":

It is practicable to purify the sewage of towns to any degree required, either by land treatment or by artificial filters, and there is no essential difference between the two processes. The main questions, therefore, to be considered in the case of a town proposing to adopt a system of sewage purification are, first, what degree of purification is required in the circumstances of that town, and of the river or stream into which its liquid refuse is to be discharged; and, secondly, how the degree of purification required can, in the particular case, be most economically obtained.

REMOVAL OF SUSPENDED MATTERS.—We find that it is generally desirable to remove from the sewage, by a preliminary process, a considerable proportion of the grit and suspended matters before attempting to purify the sewage on land or filters.

SEDIMENTATION TANKS.—Two to three hours quiescence is usually sufficient to produce a tank liquor fairly free from suspended solids, but owing to the fact that some sewages contain a larger proportion than others of solids that settle very slowly, no general rule can be laid down as to the necessary period of quiescence. With this form of treatment the deposit in the tanks should be frequently removed. The amount of settlement effected does not depend alone upon the period of flow, but upon a number of other factors. If the tank liquor is to be treated upon filters of fine material, the period of flow should generally be from 10 to 15 hours. The tanks should be cleaned out at least once a week.

SEPTIC TANKS.—All the organic solids present in sewage are not digested by septic tanks, the actual amount of digestion varying with the character of the sewage, the size of the tanks relative to the volume treated, and the frequency of cleansing. With a domestic sewage, and tanks worked at a 24-hr. rate, the digestion is about 25%. The liquor issuing from septic tanks is bacteriologically almost as impure as the sewage entering the tanks. Domestic sewage which has been passed through a septic tank is not more easily oxidized in its passage through filters than domestic sewage which has been subjected to chemical precipitation or simple sedimentation.

No definite rules can be laid down as to how long a septic tank should be run without cleaning. In the case of small sewage works (serving populations of, say, 100 to 10,000 persons), the tanks should generally be allowed to run, without cleaning, so long as the suspended matter in the tank liquor shows no signs of affecting the filters injuriously. For larger works it would generally be advisable to run off small quantities of sludge at short intervals of time.

The rate of flow through a septic tank is a matter in which the needs of each place require special consideration, but at few places should the sewage be allowed to take longer than 24 or less 12 hours to flow through the tank.

In no case should less than two tanks be provided, and they should be arranged so that, if necessary, one tank can be used alone. As regards digestion of sludge and quality of tank liquor, a closed tank possesses no advantages over an open tank. There is less risk of nuisance if the tank and the feed channels to the filters are covered in. By passing septic tank liquor through tanks of a size sufficient to hold about one-quarter of the day's flow, with the addition of from 2 to 3 grains of lime per gallon to the liquor, the suspended solids in the liquor are materially reduced, a considerably larger quantity of the liquor can be treated per cube yard of filter, and the offensive character of the liquor is largely destroyed.

CHEMICAL PRECIPITATION.—In the case of sewages which contain certain trade waste, and strong sewages from water-closet towns, it is generally desirable to subject the sewage to some form of chemical treatment before attempting to oxidize the organic matter contained in it. In most cases careful chemical precipitation materially aids the deposition of the suspended solids, and facilitates subsequent filtration. No general rule can be stated with regard to the capacity of precipitation tanks. With continuous flow, an eight hours' rate is usually sufficient to produce a fairly good tank liquor from a domestic sewage of average strength. If sewage is allowed to remain quiescent in the tank, two hours' settlement would usually suffice.

RELATIVE COST OF DIFFERENT TANK TREATMENTS.—In the absence of special circumstances favoring a particular plan, it would appear that there is very little difference in annual cost between the various methods of tank treatment when taken in conjunction with the cost of subsequent filtration through percolating filters, assuming that the kind of filter adopted in each case is that which is best adapted to the particular tank treatment provided.

FILTERS.—Within ordinary limits, the depth of a contact bed makes, practically, no difference in its efficiency per cube yard. We think that it would be generally inadvisable to construct contact beds of a greater depth than 6 ft. or of a less depth than 2 ft. 6 ins. For practical purposes and assuming good distribution, the same purification will be obtained from a given quantity of *coarse* material, whether it is arranged in the form of a deep or of a shallow percolating filter, if the volume of sewage liquor treated per cube yard be the same in each case.

With regard to percolating filters of *fine* material, if the liquid to be purified were absolutely free from suspended and colloidal solids, and if thorough aeration could be maintained, the statement just made for filters of coarse material might possibly hold good for filters of fine materials also. In practice, however, these conditions can scarcely be maintained with large rates of flow, and we think that the greatest efficiency can be got out of a given quantity of *fine* material by arranging it in the form of a shallow filter rather than of a deep filter. But we are not in a position to make an exact quantitative statement as to the difference in efficiency of the two forms.

The amount of sewage which can be purified per cube yard of contact bed or of percolating filter varies—within practical limits—nearly inversely as the strength of the liquor treated. This statement is based on the assumption that the size of the material of which the filter is composed is, in each case, suitable to the character of the liquor treated, and that the material is arranged at the proper depth to secure maximum efficiency.

Taking into account the gradual loss of capacity of contact beds, a cubic yard of material arranged in the form of a percolating filter will generally treat about twice as much tank liquor as a cubic yard of material in a contact bed. In the case of sewage containing substances which have an inhibitory effect upon the activity of micro-organisms, the working power per cube yard of filter of either type may be more nearly equal. This point, however, is not clearly established.

Percolating filters are better adapted to variations of flow than contact beds. Effluents from percolating filters are usually much better aerated than effluents from contact beds, and, apart from suspended solids, are of a more uniform character. On emptying a contact bed, the first flush is usually much more impure than the average effluent from the bed. The risk of nuisance from smell is greater with percolating filters than with contact beds. With percolating filters there is apt to be nuisance from flies, especially with filters constructed of coarse filtering material. In the warmer months of the year such filters swarm with members of the *Psychodidae*, which, though appearing to breed and develop in the filters, may usually be seen in large numbers on the walls of houses, or buildings close to or on the works.

TREATMENT OF SEWAGE ON LAND.—There is no essential distinction between effluents from land and effluents from artificially constructed filters. Effluents from those soils which are particularly well adapted for the purification of sewage contain only a very small quantity of unoxidized organic matter, and are usually of a higher class than effluents from artificial filters as at present constructed and used. Effluents from soils which are not well adapted for the purification of sewage may often be very impure.

EFFECT OF TRADE EFFLUENTS ON SEWAGE PURIFICATION.—All the trade effluents of which we have had experience interfere with or retard processes of purification to some extent, but we are not aware of any case where the admixture of trade refuse makes it impracticable to purify the sewage upon land or by means of artificial processes, although in certain extreme cases special processes of preliminary treatment may be necessary.

NUISANCE FROM SMELL.—All sewage works are liable, at times, to give off unpleasant smells; they should, therefore, be situated away from dwelling-houses,

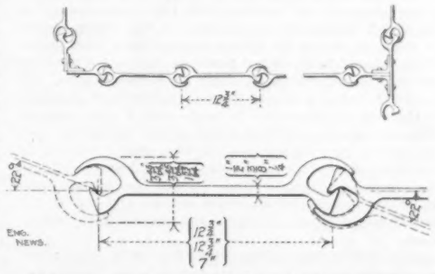


Fig. 3. Lackawanna Interlocking Steel Sheet Piling. (Lackawanna Steel Co., New York, Makers.)

wherever this is practicable. The nuisance is apt to be considerably greater where the sewage contains brewery refuse in any quantity; but, on the other hand, the presence of some trade effluents—such, e. g., as iron salts or tarry matters—tends to render the process of purification less offensive. The extent of the risk of nuisance depends, however, not only on the character of the sewage, but also on the method of treatment adopted.

GENERAL OBSERVATIONS BEARING ON CHOICE OF A METHOD OF SEWAGE TREATMENT.—The selection of a method of sewage disposal should depend primarily on local conditions. If a sufficient quantity of good land, to which the sewage can gravitate, can be purchased for about £100 [$500] an acre, land treatment would usually be the cheapest method to adopt. In cases where only clay land is available, it would gen-

*Fifth Report of the Commissioners Appointed to Inquire and Report what Methods of Treating and Disposing of Sewage (including any Liquid from any Factory or Manufacturing Process) may properly be Adopted: Methods of Treating and Disposing of Sewage. Price, 2s. 9d. Wyman & Sons, Ltd.

erally be cheaper and more satisfactory to provide artificial filters. Given conditions favorable to each process, there is little difference as regards cost between any of the different forms of tank treatment when these are considered along with the cost of subsequent filtration. Single contact will, generally, only yield a good effluent where the sewage to be treated is weak, and then only after good preliminary treatment. For the purification of partially settled weak sewage, and for well, as also for partially, settled sewage of average strength, if the case is one in which a good effluent is required, double contact is necessary, while if a strong sewage has to be treated, triple contact is necessary, unless the preliminary treatment is exceptionally good. In nearly every case a greater rate of filtration per cube yard can be adopted if the material is arranged in the form of a percolating filter than if it is used in contact beds. In many cases the rate of filtration through percolating filters may be double or nearly double what it could be with contact beds. Where the liquor to be treated contains much suspended matter, it is usually advisable to construct filters, whether contact or percolating, with coarse filtering material. Where the preliminary treatment has effectively removed the greater part of the suspended matter it is best to use fine material in the filters.

STORM OVERFLOWS ON BRANCH SEWERS.—Storm overflows on branch sewers should be used sparingly, and should usually be set so as not to come into operation until the flow in the branch sewer is several times the maximum normal dry-weather flow in the sewer. No general rule can be laid down as to the increase in flow which should occur in the branch sewers before sewage is allowed to pass away by the overflow untreated. The Rivers Board, or in districts where there is no Rivers Board, the county council, should have power to require the local authority to alter any storm overflows, which, in their opinion, permit of an excessive amount of unpurified sewage to flow over them. The local authority should have the right to appeal to the central authority in any case in which they consider that the requirement of the Rivers Board is unreasonable or impracticable of fulfilment. The general principle should be to prevent such an amount of unpurified sewage from passing over the overflow as would cause nuisance.

TREATMENT OF STORM WATER SEWAGE AT THE WORKS.—As a general rule, special stand-by tanks (two or more) should be provided at the works, and kept empty for the purpose of receiving the excess of storm water which cannot properly be passed through the ordinary tanks. As regards the amount which may be properly passed through the ordinary tanks, our experience shows that in storm times the rate of flow through these tanks may usually be increased to about three times the normal dry-weather rate without serious disadvantage. The overflow at the works should be made from these special tanks, and should be arranged so that it will not come into operation until the tanks are full. Special filters which are only used in times of storm are not usually efficient, and should not be provided. Any extra quantity of sewage arriving at the works in storms, which has to be filtered, should be treated on the ordinary filters, which should be made sufficiently large for the purpose.

As regards the size of the stand-by tanks, the amount of storm water sewage to be filtered, and the arrangements generally for dealing with the storm sewage at the outfall works, the Rivers Board or the county council in areas in which no Rivers Boards have been established, should have similar power to that which we have proposed in regard to overflows on branch sewers, and the local authority should have a similar right of appeal to the central authority. In most cases it will probably suffice to provide stand-by tanks capable of holding one-quarter of the daily dry-weather flow, and it will not be necessary to provide for *filtering* more than three times the normal dry-weather flow. Under the arrangements which we recommend no storm sewage arriving at the outfall works would be discharged without some settlement.

STANDARDS FOR SEWAGE EFFLUENTS.—Our terms of reference require us to have regard to the "*economical* and efficient" discharge of the duties of local authorities, and in view of the importance of not requiring a local authority to incur any further expenditure on sewage disposal than the circumstances of its area require, we feel strongly that the law should be altered so as to allow local circumstances to be taken into account. We recommend that the central authority should determine the nature of the tests which are to be applied for the purpose of standards, and that it should be made the duty of the Rivers Board, or of the county council in areas not under the jurisdiction of a Rivers Board, to determine, from time to time, subject to appeal to the central authority, what standards should be adopted. In the first instance it would be convenient that the central authority should prescribe one standard for all non-tidal waters, in place of the existing statutory provisions. It would then rest with the Rivers Board or county council to fix, subject to appeal to the central authority, a higher or lower standard in any case in which they were of opinion that the circumstances required or justified a different standard.

We further recommend that no action should be allowed to be brought in respect of damage alleged to be due to the discharge of an effluent which complies with the standard fixed for the water into which it is discharged, but that in such cases complaint should be made to the central authority, and, if a *prima-facie* case is made out, that authority should ascertain whether the complaint is well founded, and should be empowered to fix a different standard if the circumstances are shown to require it. In cases where it is alleged that the effluent does not comply with the statutory standard, and that damage is caused by the discharge of such effluent, action should be brought in the ordinary courts. But any questions arising as to whether the effluent complies with the statutory standard, or as to whether the damage has been caused by the discharge of the effluent in respect of which complaint is made, should be referred by the court to the central authority for determination. The costs of such determination should be borne by the parties to the action in such proportions as the court may determine. Power should be conferred on the central authority to suspend, from time to time, the operation of any standard, to allow time for the construction of works, or for any other reason which, in their opinion, justified such suspension.

TESTS FOR SEWAGE EFFLUENTS IN RELATION TO STANDARDS.—According to our present knowledge, an effluent can best be judged by ascertaining, first, the amount of suspended solids which it contains, and, second, the rate at which the effluent, after the removal of the suspended solids, takes up oxygen from water. In applying this test it is important that the suspended solids should be removed, and estimated separately. For the guidance of local authorities we may provisionally state that an effluent would generally be satisfactory if it complied with the following conditions:

(1) That it should not contain more than 3 parts per 100,000 of suspended matter; and

(2) That, after being filtered through filter paper, it should not absorb more than:

(a) 0.5 part by weight per 100,000 of dissolved or atmospheric oxygen in 24 hours; (b) 1.0 part in 48 hours; or (c) 1.5 parts in five days.

THE CENTRAL AUTHORITY.

To secure the economical and efficient discharge of the duties of local authorities and others in regard to pollution, and adequately to protect the public health and the amenities of rivers, the statutory provisions in regard to these matters must be of an elastic character. The conditions of different cases vary to such an extent that the necessary control cannot, in our opinion, be provided by any direct enactment which could be enforced by the ordinary courts. Throughout our reports this fact has been fully recognized, and we have proposed, in regard to many matters, that ultimate control should be vested in an adequately equipped central administrative authority, and that, as far as practicable, the local Rivers Board should, in accordance with regulations framed by the central department, act as a first tribunal.

Among the more important questions which have to be dealt with under the new conditions of administration which we are contemplating are the following:

(1) Disputes between local authorities and manufacturers as to the terms and conditions on which trade effluents shall be admitted into sewers.

(2) The control of shell-fish layings so as to prevent the taking of shell-fish for human consumption from positions in which they are liable to risk of dangerous contamination.

(3) The protection of water supplies from pollution.

(4) The collection of information as to the water supplies available in various parts of the country.

(5) The collection of information as to the need of water in various parts of the country.

(6) The settlement of standards for different reaches of water.

(7) Conferring powers on local authorities, in suitable cases, to provide separate systems of sewers for surface water and to enforce the provision of separate drains.

(8) The settlement of questions as to the extra amount of sewage which a local authority should be required to treat during storms.

There are also numerous questions in regard to the purification of polluting liquids which, in the interests of the public, have still to be worked out, and it is essential that the central authority should be properly equipped for undertaking such special investigations as they may from time to time find necessary, and for collecting and collating the work done by others. Since the date of our appointment considerable developments have taken place in regard to the disposal of sewage, and there is every reason to think that further changes will occur in the future. Unless the central department keep in close touch with all such changes, and from time to time report on them, it is not possible for local authorities throughout the country fully to utilize the results of valuable work which is being done at many places, and hence to perform their duties in the most economical as well as efficient manner.

For the benefit of such of our readers as may not know, it may be stated that at present the Local Government Board has control over *loan* expenditures for sewage disposal in England and Wales, while a few special commissions have regulative control of the discharge of sewage into a half dozen or so streams. The Local Government Board, has, in effect, adopted arbitrary rules governing the character of sewage disposal works built under its sanction and has, for the most part, enforced the rules with but little regard for local conditions. Judging from the present and from one of the earlier reports of the Commission it favors (1) an independent central body, devoted wholly to sewage disposal or to this and certain aspects of public water supplies; (2) an increase in the number and enlargement of the powers of the river boards; (3) that the latter should have executive control and primary jurisdiction over sewage disposal in their respective localities, in accordance with general rules laid down by the central authority, and subject to appeal to the central authority.

PERSONAL GLIMPSES OF THE LIFE AND WORK OF LORD KELVIN.*

By Prof. SILVANUS P. THOMPSON, D.Sc., F.R.S., Past President, Inst. E. E.

On Dec. 17, 1907, aged 83 years, died William Thomson, Baron Kelvin, of Largs, President, for the third time, of the Institution of Electrical Engineers.

Adequately to set forth the life and work of a man who so early won and who for so long maintained a foremost place in the ranks of science were a task that is frankly impossible. The greatness of a man of such commanding abilities and such profound influence cannot rightly be gaged by his contemporaries, however intimately they may have known him. We of the present day are so essentially products of our generation, and have been brought up in modes of thought so largely molded by him, that we cannot adequately realize how much of that which is familiar and commonplace to us is due to his genius. But if by the very circumstance that we have lived so near to him we are debarred from rightly estimating his greatness, we at least have the advantage over posterity that we have been able to speak with him face to face, to learn at first hand his modes of thought, to sit at his feet as students or disciples, to marvel at his strokes of genius achieved before our very eyes, to learn to love him for his single-hearted enthusiasm, for his kindliness of soul, his unaffected simplicity of life.

William Thomson was born on June 26, 1824, in Belfast, being the second son and fourth child of James and Margaret Thomson. James Thomson, who was at that time Professor of Mathematics in the Royal Academic Institute of Belfast, was the son of a small farmer at Ballynahinch, in County Down, where his ancestors had settled about the year 1641 when they migrated from the lowlands of Scotland. James Thomson had early shown a taste for mathematical studies, and by study of books had mastered the art of making sun dials. He had then been sent to a small school in the district to learn classics and mathematics, rising while still a youth to the position of assistant teacher.

He was in many ways a remarkable man. He made several original contributions to mathematics, and produced several sound text-books, including one on the Differential and Integral Calculus. After his removal to Glasgow he still kept the education of his sons in his own hands, and so it happened that in 1834 William Thomson, when in his eleventh year, matriculated as a student in the University without ever having been at school. He early made his mark by his progress in mathematics and physical science, and in 1840 produced an essay, "On the Figure of the Earth," which won him the University Medal. He also read Greek plays and moral philosophy, and to the end of his life he was in the habit of bringing out quotations from the classic authors. His fifth year as a student at Glasgow, 1839-40, was notable for the impulse toward physics which he received from the lectures of Professor J. P. Nichol and from those of David Thomson (a relation of Faraday), who temporarily took the classes in natural philosophy during the illness of Professor Meikleham. In this year William Thomson had systematically studied the "Mécanique Analytique" of Lagrange and the "Mécanique Celeste" of Laplace, both mathematical works of a high order, and had made the acquaintance—a notable event in his career—of that remarkable book, Fourier's "Théorie de la Chaleur." On May 1st he borrowed it from the College Library. In a fortnight he had read it completely through. The effect of reading Fourier dominated his whole career thenceforward. He left Glasgow

*Extracts from the Kelvin Lecture, delivered April 30, before the Institution of Electrical Engineers, London.

University after six years of study, without even taking his degree, and on April 6, 1841, entered as a student at St. Peter's College, Cambridge. Here he speedily made his mark and continued to contribute to the "Cambridge and Dublin Mathematical Journal," papers inspired by his study of the higher mathematics and by his love for physics.

He was an undergraduate of seventeen handling methods of difficult integration readily and with mastery, at a time when most mathematical students are being assiduously drilled in so-called geometrical conics and other useful and foolish devices for calculus-dodging. Of Thomson's Cambridge career so much has been written of it may be very briefly touched here. How he worked up for his Tripos in 1845; how he came out Second Wrangler only, being beaten by the rapid Parkinson; how he beat Parkinson in the Smith's Prize competition; how he rowed for his college to save Peterhouse from being bumped by Caius; how he rowed for Cambridge in the University race of 1844; how he won the Colquhoun silver sculls; how he helped to found the Cambridge University Musical Society, and played the French horn in the little orchestra.

On leaving Cambridge, with a College Fellowship of £200 a year to maintain him, Thomson went to Paris and worked in the laboratory of Regnault at the Collège de France. He was here four months. There was no arrangement for systematic instruction, and Thomson's principal occupation was to work the air-pump to make a vacuum in one of two large glass globes which Regnault was weighing against one another in some determinations of the densities of gases. He made here the acquaintance of Biot and of Sturm and Foucault, of whom he spoke in terms of admiration.

Thomson was now 21 years old, but had already established for himself a growing reputation for his mastery of mathematical physics. He had published about a dozen original papers, and had gained experience in three universities. In 1846 the Chair of Natural Philosophy at Glasgow became vacant by the death of Professor Meikleham, and Thomson, at the age of 22, was chosen to fill it. His father, Prof. James Thomson—he died in 1849—still held the Chair of Mathematics, Prof. Thomas Thomson held that of Chemistry, while Prof. Allen Thomson occupied the Chair of Anatomy. William Thomson was the youngest of the five Professor Thomsons then holding office in Glasgow.

This Professorship he continued to hold till he resigned it in 1899 after continuous service of 53 years. The old college buildings where he lectured and worked for 24 years were ill-adapted for any laboratory facilities, yet he contrived to organize a physics laboratory—the first of its kind in Great Britain—in some disused rooms in a dark corner of one of the quadrangles, and enlisted the voluntary service of a number of keen students in his early experimental researches on the electrodynamic and thermoelectric properties of matter. In the lecture theater his manifest enthusiasms won for him the love and respect of all students, even those who were hopelessly unable to follow his frequent flights into the more abstruse realms of mathematical physics.

The next few years were times of strenuous work, fruitful in results. By the end of 1850, when he was 26 years of age, he had published no fewer than fifty original papers, mostly highly mathematical in character, and several of them in French. Among these researches there is a remarkable group which originated in his attendance in 1847 at the meeting of the British Association. Here was the commencement of his friendship with Joule. Joule, a Manchester brewer, and Honorary Secretary of the Manchester Literary and Philosophical Society, had for several years been pursuing his researches on the relations between heat, electricity, and mechanical work. But at that date, when there was as yet no doctrine of Conservation of Energy, when scientific men were not accustomed to distinguish either in language or in fact between force and work, when "caloric" was classed with light and sound among the "Imponderables," Joule's work was listened to with impatience, and his teachings fell upon deaf ears. Was he not an amateur, dabbling in science, and carried away with strange notions? For the Oxford meeting, too, Joule had prepared a paper. Its title was, "On the Mechanical Equivalent of Heat, as Determined from the Heat Evolved by the Agitation of Liquids." It was relegated to an unimportant place, and would have received as little notice as its predecessors but for Thomson's intervention.

Thomson, in fact, though he at first had some difficulty in grasping the significance of the matter, threw himself heart and soul into the new and strange doctrines that heat and work were mutually convertible, and for the next six or eight years, partly in cooperation with Joule, partly independently, he set his unique powers of mind to unravel those mutual relations.

Thomson's mind was essentially metrical. He was never satisfied with any phenomenon until it should have been brought into the stage where numerical accuracy could be determined. He must measure, he must weigh, in order that he might go on to calculate. It was in this spirit that Thomson approached the subject of the transformation of heat.

Joule had laid down on certain lines the equivalence of heat and work, and had even measured the numerical value of the equivalent. In 1824, Carnot had discussed the proportion in which heat is convertible into work, and had introduced the very valuable notion of submitting a body to a reversible cycle of operations such that after having experienced a certain number of transformations it is brought back identically to its primitive physical state as to density, temperature, and molecular constitution. Those who were investigating the subject at this time, among them Clapeyron, Clausius, and Rankine, noted that since the steam received into the cylinder must be hotter than that expelled from it, the degree to which the transformation is successful must depend on the respective temperatures. Carnot, indeed, proved that the ratio of the work done by a perfect engine to the heat received from the source depends on the temperatures of source and condenser only. Rankine went further in pointing out that this function was greater as the temperature in question was lower.

Here Thomson's exact mind seized upon the missing essential. Temperatures had hitherto been measured by arbitrary scales based on the expansion of quicksilver, or of air or other gas; and the quicksilver thermometer scale did not agree precisely with that of the air thermometer. He was not satisfied with arbitrary scales. He had this in hand even before his first meeting with Joule, and in June, 1848, communicated to the Cambridge Philosophical Society a paper "On an Absolute Thermometric Scale founded on Carnot's Theory of the Motive Power of Heat, and Calculated from Regnault's Observations." In this paper he set himself to answer the question: Is there any principle on which an absolute thermometric scale can be founded? He arrived at the answer that such a scale is obtained in terms of Carnot's theory, each degree being determined by the performance of equal quantities of work in letting one unit of heat be transformed in being let down through that difference of temperature. This indicates as the absolute zero of temperature the point which would be marked as—273° on the air-thermometer scale.

Thomson continued to work at the subject. He experimented on the heat developed by compression of air. He verified the singular prediction of his brother, Professor James Thomson, of the lowering by pressure of the melting-point of ice. He gave a thermodynamic explanation of the non-scalding property of steam issuing from a high-pressure boiler. He formulated, in the years 1851 to 1854, with scientific precision, in a long communication to the Royal Society of Edinburgh, the two great laws of thermodynamics—(1) the law of equivalence discovered by Joule, and (2) the law of transformation, which he generously attributed to Carnot and Clausius. Clausius, indeed, had done little more than put into mathematical language the equation of the Carnot cycle, corrected by the arbitrary substitution of the reciprocal of the absolute temperature; but Thomson never was grudging of the fame of independent discoverers. He gave a demonstration of the second law, founding it upon the axiom that it is impossible, by means of inanimate material agency, to derive mechanical effect from any portion of matter by cooling it below the temperature of the coldest of the surrounding objects. Further, by a most ingenious use of the integrating factor to solve the differential equation for the quantity of heat needed to alter the volume and temperature of unit mass of the working substance, he gave precise mathematical proof of the theorem that the efficiency of the perfect engine working between given temperatures is inversely proportional to the absolute temperature. In collaboration with Joule, he worked at the "Thermal Effects of Fluids in Motion," the results appearing between the years 1852 and 1862 in a series of four papers in the "Philosophical Transactions," and four others in the "Proceedings" of the Royal Society. Thus were the foundations of thermodynamics laid. This brilliant development and generalization of the subject (which had grown with startling rapidity from the moment when Helmholtz denied perpetual motion and Thomson grasped the conception of the absolute zero) did not content Thomson. He must follow its applications to human needs and to the cosmic consequences it involved. And so he not only suggested the process of refrigeration by the sudden expansion of compressed cooled air, but propounded the doctrine of the dissipation of energy.

In 1852, at the age of 28, William Thomson married Margaret Crum, and resigned his Cambridge Fellowship. The happiness of his life was, however, shadowed by his wife's precarious health, necessitating residence abroad at various times. In the summer of 1855 they stayed at Kreutznach, from which place Thomson wrote to Helmholtz inviting him to come to England in September to attend the British Association meeting at Glasgow. Accordingly, on July 29th, Helmholtz left Königsberg for Kreutznach to make the acquaintance of Thomson before his journey to England. On Aug. 6 he wrote to Frau Helmholtz that Thomson had made a deep impression on him.

I expected to find the man, who is one of the first mathematical physicists of Europe, somewhat older than myself, and was not a little astonished when a very juvenile and exceedingly fair youth, who looked quite girlish, came forward. He had taken a room for me close by, and made me fetch my things from the hotel and put up there. He is at Kreutznach for his wife's health. She appeared for a short time in the evening, and is a charming and intellectual lady, but is in very bad health. He far exceeds all the great men of science with whom I have made personal acquaintance, in intelligence, and lucidity, and mobility of thought, so that I felt quite wooden beside him sometimes.

A year later Helmholtz again met the Thomsons at Schwalbach. Writing to his father, he described Thomson as "certainly one of the first mathematical physicists of the day, with powers of rapid invention such as I have seen in no other man." In 1860, after the death of Mrs. Helmholtz, the great German philosopher again visited Britain, staying with the Thomsons for some weeks in the island of Arran. In 1863 Helmholtz, who in the meantime had married again, came to England and visited the chief universities, and in writing to his wife gives an amusing picture of his doings.

My journey to Glasgow went off very well. The Thomsons have lately moved to live in the University Buildings [the old college]; formerly they spent more time in the country. I have seen a quantity of new and most ingenious apparatus and experiments of W. Thomson, which made the two days very interesting. He thinks so rapidly, however, that one has to get at the necessary information about the make of the instruments, etc., by a long string of questions, which he shies at. How his students understand him, without keeping him as strictly to the subject as I ventured to do, is a puzzle to me; still, there were numbers of students in the laboratory hard at work, and apparently quite understanding what they were about. Thomson's experiments, however, did for my new hat. He had thrown a heavy metal disk into very rapid rotation, and it was revolving on a point. In order to show me how rigid it became on rotation, he hit it with an iron hammer, but the disk resented this, and it flew off in one direction, and the iron foot on which it was revolving in another, carrying my hat away with it and ripping it up.

But we are anticipating. Hitherto Thomson's work had been mainly in pure science; but toward the end of the fifties, while still in the midst of thermodynamic studies, events were progressing which drew him with irresistible force toward the practical applications that made him famous. Indeed, it could hardly be otherwise, seeing that he was master in whatever he touched. Early in 1853 he had communicated to the Glasgow Philosophical Society a paper "On Transient Electric Currents," in which he investigated mathematically the discharge of a Leyden jar through circuits possessing self-induction as well as resistance. Faraday and Riess had observed that in certain cases the gases produced by the discharge of sparks through water consisted of mixed oxygen and hydrogen, and Helmholtz had conjectured that in such cases the spark was oscillatory. Thomson determined to test mathematically what was the motion of electricity at any instant after making contact in a circuit under given conditions. He founded his solution on the equation of energy, ingeniously building up the differential equation and then finding the integral. The result was very remarkable. He discovered that a critical relation occurred if the capacity in the circuit was equal to four times the coefficient of self-induction divided by the square of the resistance. If the capacity was less than this the discharge was oscillatory, passing through a series of alternate maxima and minima before dying out. If the capacity was greater than this the discharge was non-oscillatory, the charge dying out without reversing. This beautiful bit of mathematical analysis, which passed almost unnoticed at the time, laid the foundation of the theory of electric oscillations subsequently studied by Oberbeck, Schiller, Hertz, and Lodge, and forms the basis of wireless telegraphy.

The "Proceedings of the Royal Society" for 1854 contain the investigation of cables under the title, "On the Theory of the Electric Telegraph." Faraday had predicted that there would be retardation of signals in cables owing to the coating of gutta-percha acting like the glass of a Leyden jar. Forming the required differential equation, and applying Fourier's integration of it, Thomson drew the conclusion that the time required for the current at the distant end to reach a stated fraction of its steady value would be proportional both to the resistance and to the capacity; and as both of these are proportional to the length of the cable, the retardation would be proportional to the square of the length. This is the famous lay of squares about which so much dispute arose. This was followed by a further research, "On Peristaltic Induction of Electric Currents," communicated to the British Association in 1855, and afterward in more complete mathematical form to the Royal Society.

Submarine telegraphy was "in the air." John and Jacob Brett had pioneered the project for a Dover-Calais cable; and in 1851 Crampton successfully united England and France. In 1853 Holyhead and Howth were connected by Mr. (later Sir) Charles Bright. And these were followed by the Dover-Ostend and longer cables. Atlantic telegraphy became the dream of the telegraph engineer. Cyrus W. Field, in 1856, negotiated a cable across the Gulf of St. Lawrence, thus connecting Newfoundland to the American continent. The Atlantic Telegraph Company was formed, with capital mostly subscribed in England, to promote the great enterprise to

join Ireland to Newfoundland. Field, Brett, Bright, Statham, and Wildman Whitehouse were the chief promoters. Bright was engineer, Whitehouse (a retired medical man) electrician. In a pamphlet issued by the company, in July, 1857, narrating the preliminary proceedings, the names of John Pender, of Manchester, and Professor Thomson, of "2, The College, Glasgow," are included in the list of the directors; and the statement is made that "the scientific world is particularly indebted to Professor W. Thomson, of Glasgow, for the attention he has given to the theoretical investigation of the conditions under which electrical currents move in long insulated wires, and Mr. Whitehouse has had the advantage of this gentleman's presence at his experiments, and counsel, upon several occasions, as well as the gratification resulting from his countenance and cooperation as one of the directors of the company."

This is one side of the matter. The other side is that Mr. Whitehouse had at the British Association meeting of 1856 read a paper challenging the law of squares, and declaring that if it was true Atlantic telegraphy was hopeless. He professed to refute it by experiments, the true significance of which was disposed of by Thomson in two letters in "The Athenæum." Thomson here pointed out that success lay primarily in adequate section of conductor, and hinted at a remedy (deduced from Fourier's equations) which he later embodied in the curb signal transmitter, namely, that the coefficient of the simple harmonic term in the expression for the electrical potential shall vanish. In December, 1856, he described to the Royal Society his plan for receiving messages, namely, a sort of Helmholtz tangent galvanometer, with copper damper to the suspended needle, the deflections being observed by watching through a reading telescope the image of a scale reflected from the polished side of the magnet or from a small mirror carried by it. As we all know, he abandoned this subjective method for the objective plan in which a spot of light from a lamp is reflected by the mirror upon a scale. There is a pretty story—which is believed to be true—that the idea of thus using the mirror arose from noticing the reflection of light from the monocle which, being short-sighted, he wore hung round his neck with a ribbon.

The story of the Atlantic cable, of the failure of 1857, of the brief success of 1858, has so often been told that it need not be emphasized here. Thomson, after the failure of the first attempt, was called upon to take a more active part. He had discovered to his surprise that the conductivity of copper was greatly affected by its purity. So he organized a system of testing conductivity at the factory where the additional lengths were being made, and was put in charge of the test-room on board the "Agamemnon" in 1858. Whitehouse was unable to join the expedition, and Thomson, at the request of the directors, undertook the post of electrician in charge, without any recompense, though the tax on his time and energies was very great.

Sir Charles Bright has given us the following little silhouette of Thomson:

> As for the Professor . . . he was a thorough good comrade, good all round, and would have taken his "turn at the wheel" [of the paying-out brake] if others had broken down. He was also a good partner at whist when work wasn't on; though sometimes, when momentarily immersed in cogibundity of cogitation, by scientific abstraction, he would look up from his cards and ask, "Wha played what?"

After various disheartening mishaps, success crowned their efforts. Throughout the voyage Thomson's mirror galvanometer had been used for the continuity tests and for signaling to shore, with a battery of seventy-five Daniell's cells. The continuity was reported perfect, and the insulation had improved on submersion. On Aug. 5 the cable was handed over to Mr. Whitehouse and reported to be in perfect condition. Whitehouse at once abandoned the Thomson mirror instruments and began working with his own patented apparatus, using heavy relays and a special transmitter with induction coils. He sent in no report to the directors for a week, while he made ineffectual attempts with bigger induction coils to get his apparatus to work. After more than a week the reflecting galvanometer and ordinary Daniell cells were resumed, and then clear messages were interchanged and international congratulations. News of peace with China and of the end of the Indian Mutiny was transmitted; but the insulation was found to be giving way, and on Oct. 20, after 732 messages had been conveyed, the cable spoke no more. It had been destroyed by Whitehouse's bungling use of induction coils—some 5 ft. long—working at some 2,000 volts.

Of the part played by Thomson in the next eight years, in preparation for the cables of 1865 and 1866, there is not time to speak. Suffice it to say that throughout the preparations, the preliminary trials, the interrupted voyage of 1865, when 1,000 miles were lost, the successful voyage of 1866, when the new cable was laid and the lost one recovered from the ocean and completed, Thomson was the ruling spirit whose advice was eagerly sought and followed. On his return he was knighted for the part he had played so well. He had in the meantime made further improvements in conjunction with Cromwell Varley. In 1867 he patented the siphon recorder, and in conjunction with Fleeming Jenkin, the curb-transmitter. He was consulted on practically every submarine cable project from that time forth.

Thomson's activities during the sixties were immense. Beside all this telegraphic work he was incessant in research. When, in 1861, Sir Charles Bright and Mr. Latimer Clark proposed the names of ohm, volt, and farad for the practical units based on the centimeter-gramme-second absolute system, Sir William Thomson gave a cordial support; and on his initiative was formed the famous Committee of Electrical Standards of the British Association, which year by year has done so much to carry to perfection the standards and the methods of electrical measurement. He was largely responsible for the international adoption of the system of units by his advocacy of them at the Paris Congress in 1881, and in subsequent congresses. He was an uncompromising advocate of the metric system, and lost no opportunity of denouncing the "absurd, ridiculous, time-wasting, brain-destroying British system of weights and measures." As early as 1851 he had begun to use the absolute system, stimulated thereto by the earlier work of Gauss and Weber. The fact that terrestrial gravity varies at different regions of the earth's surface by as much as ½ of 1%, compelled the use of absolute methods where any greater accuracy than this is required. "For myself," he said, "what seems the shortest and surest way to reach the philosophy of measurement—an understanding of what we mean by measurement, and which is essential to the intelligent practice of the mere art of measuring—is to cut off all connection with the earth." And so he imagined a traveller with no watch, or tuning fork, or measuring rod, wandering through the universe trying to recover his centimeter of length and his second of time, and reconstructing thereupon his units and standards from the wave-length of the yellow light of sodium and the value of *v*, the velocity of light, from experiments on the oscillations in the discharge of a Leyden jar! Some here remember how we listened amazed to this characteristic and bewildering excursus.

Among the activities of these fruitful years was a long research on the electrodynamic qualities of metals, thermoelectric, thermoelastic, and thermomagnetic. He worked hard also at the mathematical theory of magnetism. Faraday's work on diamagnetism had appeared while Thomson was a student at Cambridge. It established the fact that magnetic forces were not mere actions at a distance between supposed poles, but actions dependent on the surrounding medium; and Thomson set himself to investigate the matter mathematically. Faraday and Fourier had been the heroes of Thomson's youthful enthusiasm; and, while the older mathematicians shook their heads at Faraday's heretical notion of curved lines of force, Thomson had, in 1849 and 1850, developed a new theory with all the elegance of a mathematical disciple of Poisson and Laplace, discussing solenoidal and lamellar distributions by aid of the hydrodynamic equation of continuity. To Thomson we owe the terms "permeability" and "susceptibility," so familiar in the consideration of the magnetic properties of iron and steel. He continued to add to and revise this work through the sixties and seventies.

In 1859-60 Thomson was studying atmospheric electricity, writing on it in Nichol's "Cyclopedia," and lecturing on it at the Royal Institution. For this study he invented the water-dropping collector, and vastly improved the electrometer, which developed into elaborate forms of the quadrant instrument and other types.

In the winter of 1860-61 Thomson met with a severe accident. He fell on the ice when engaged at Largs in the pastime of curling, and broke the neck of his thigh. For several months he had to lie on his back; and it was at this time that he adopted the famous green note-books, which ever afterwards were the companions of his days. The accident left him with a slight limp for the rest of his life.

An admirable pen picture of Lord Kelvin as he was in the sixties, moving among his students and incessant in his researches, has been given in "The Times" of Jan. 8, 1908, by Professor Ayrton, who was then working at Glasgow. In these years Thomson was also writing on the secular cooling of the earth, and investigating the changes of form during rotation of elastic spherical shells. And, as if this were not enough to have in hand, he embarked with his friend Prof. Tait on the preparation of a text-book of Natural Philosophy. There was at that date no satisfactory work to put into the hands of students, and he must supply the need. Thomson had told Helmholtz of his purpose, and in 1862 Helmholtz wrote him:

> Your undertaking to write a text-book of Natural Philosophy is very praiseworthy, but will be exceedingly tedious. At the same time I hope it will suggest ideas to you for much valuable work. It is in writing a book like that that one best appreciates the gaps still left in science.

The first volume of Thomson and Tait's "Treatise on Natural Philosophy" was published in 1867, the second only in 1874; when it appeared that Helmholtz's hopes were just. For in approaching the subject of elasticity the gaps still left were found to be such that whole new mathematical researches were n… before Volume II. could be finished. Thomson's contributions to the theory of elasticity are no less important than those he made to other branches of ph… In 1867 he communicated to the Royal Society of Edinburgh his famous paper "On Vortex Atoms." Helmholtz had published a mathematical paper on the hydrodynamic equations of vortex motion, proving that vortices could not be produced in a liquid perfectly devoid of internal friction. Thomson seized on this. If no such vortex could be artificially produced, if such existed it could not be destroyed. But being in motion and having the inertia of rotation, it would have elastic and other properties. He showed that vortex rings (like smoke-rings in air) in a perfect medium are stable, and that in many respects they possess the essential to the properties of material atoms—permanence, elasticity, and power to act on one another through the medium at a distance. The different kinds of atoms known to the chemist as elements were to be regarded as vortices of different degrees of complexity. Though he seemed at the end of his life to doubt whether the vortex-atom hypothesis was adequate to explain all the properties of matter, the conception remains, at all times, a witness to his extraordinary powers of mind.

In 1870 Lady Thomson, whose health had been failing for several years, died. In the same year the University of Glasgow was removed from the site it had occupied for over four centuries to the new and splendid buildings on Gilmore Hill, overlooking the Kelvin River. Sir William Thomson had a house here in the terrace assigned for the residences of the professors, adjoining his laboratory and lecture-room. From his youth he had been fond of the sea, and had early owned boats of his own on the Clyde. For many years his sailing yacht, the "Lalla Rookh," was conspicuous, and he was an accomplished navigator. His experiences in cable-laying had taught him much, and in return he was now to teach science in navigation. First he reformed the mariners' compass, lightening the moving parts to avoid protracted oscillations, and to facilitate the correction of the quadrantal and other errors arising from the magnetism of the ship's hull. At first the Admiralty would have none of it. Even the Astronomer Royal condemned it. But the compass is now all but universally adopted both in the navy and in the mercantile marine.

Dissatisfied with the clumsy appliances used in sounding, when the ship had to be stopped before the sounding line could be let down, he devised the now well-known apparatus for taking flying soundings by using a line of steel piano wire. He had great faith in navigating by use of sounding line, and once told me—apropos of a recent wreck near the Lizard, which he declared would have been impossible had soundings been regularly taken—how, in a time of continuous fog, he brought his yacht all the way across the Bay of Biscay into the Solent trusting to soundings only. He was vastly interested in the question of the tides, not merely as a sailor, but because of the interest attending their mathematical treatment in connection with the problems of the rotation of spheroids, the harmonic analysis of their complicated periods by Fourier's methods, and their relation to hydrodynamic problems generally. Wave problems always had a fascination for him, and the work of the mathematicians Poisson and Cauchy on the propagation of wave-motion were familiar studies. In his lectures he used to say, "The great struggle of 1815"—and then paused, while his students, thinking of Waterloo, began to applaud—"was not that fought out on the plains of Belgium, but—who was to rule the waves, Cauchy or Poisson?" In 1871 Helmholtz went with Sir William Thomson on the yacht "Lalla Rookh" to the races at Inverary, and on some longer excursions to the Hebrides. Together they studied the theory of waves, "which he loved," says Helmholtz, "to treat as a race between us." Returning they visited many friends. "It was all very friendly," wrote Helmholtz, "and unconstrained. Thomson presumed so much on his intimacy with them that he always carried his mathematical note-book about with him, and would begin to calculate in the midst of the company if anything occurred to him, which was treated with a certain awe by the party." He possessed indeed the faculty of detachment, and would settle quietly down with his green book almost unconscious of things going on around him. On calm days he and Helmholtz experimented on the rate at which the smallest ripples on the surface of the water were propagated. Almost the last publications of Lord Kelvin were a series of papers on "Deep Sea Ship Waves," communicated between 1904 and 1907 to the Royal Society of Edinburgh.

In 1874 Sir William Thomson married Miss Frances Anne Blandy, of Madeira, whom he had met on cable-laying expeditions. Lady Kelvin, who survives him, became the centre of his home in Glasgow and the inseparable companion of all his later travels. He built at Netherhall, near Largs, a beautiful mansion in the Scottish baronial style; and though he latterly had a London house in Eaton Place, Netherhall was the home to which he retired when he withdrew from active work in the University of Glasgow.

Among the matters that cannot be omitted in any notice of his life was Lord Kelvin's controversy with the geologists. He had from three independent lines of argument inferred that the age of the earth could not be infinite, and that the time demanded by the geologists and biologists for the development of life must be false. He himself estimated it at about a hundred million years at the most. In vain did the naturalists, led by Huxley, protest. He stuck to his propositions with unrelaxing tenacity but unwavering courtesy. "Gentle knight never broke lance," was Huxley's dictum of his opponent. His position was never really shaken, though the later researches of Perry, and the discovery by Strutt of the degree to which the constituent rocks of the earth contain radioactive matter, the disintegration of which generates internal heat, may so far modify the estimate as to increase somewhat the figure which he assigned.

With the advent of electric lighting at the end of the seventies Thomson's attention was naturally attracted to this branch of the practical applications of science. He never had any prejudice against the utilization of science for practical ends. He wrote once:

> There cannot be a greater mistake than that of looking superciliously upon practical applications of science. The life and soul of science is its practical application; and just as the great advances in mathematics have been made through the desire of discovering the solution of problems which were of a highly practical kind in mathematical science, so in physical science many of the greatest advances that have been made from the beginning of the world to the present time have been made in the earnest desire to turn the knowledge of the properties of matter to some purpose useful to mankind.

And so he scorned not to devise instruments and appliances for commercial use. His electrometers, his galvanometers, his siphon-recorders, and his compasses had been made by James White, optician, of Glasgow. In this firm he became a partner, taking the keenest commercial interest in its operations, and frequenting the factory to superintend the construction of apparatus. New measuring instruments were required. He set himself to devise them, designing potential galvanometers, ampere gages, and a whole series of standard electric balances for electrical engineers.

Lord Kelvin's patented inventions were very numerous. Without counting in those since 1900, taken mostly in the name of Kelvin and James White, they number 56. He was interested even in devising such details as fuses and the suspension pulleys with differential gearing by which incandescent lamps can be raised or lowered.

He gave evidence before a Parliamentary Committee on Electric Lighting, and discussed the theory of the electric transmission of power, pointing out the advantage of high voltages. The introduction into England in 1881 of the Faure accumulator excited him greatly. In his presidential address to the mathematical and physical section of the British Association at York that year he spoke of this and of the possibility of utilising the powers of Niagara. He also read two papers, in one of which he showed mathematically that in a shunt dynamo best economy of working was attained when the resistance of the outer circuit was a geometric mean between the resistances of the armature and of the shunt. In the other he laid down the famous law of the economy of copper lines for the transmission of power.

Helmholtz, visiting him again in 1884, found him absorbed in regulators and measuring apparatus for electric lighting and electric railways. "On the whole," Helmholtz wrote, "I have an impression that Sir William might do better than apply his eminent sagacity to industrial undertakings; his instruments appear to me too subtle to be put into the hands of uninstructed workmen and officials. . . . He is simultaneously revolving deep theoretical projects in his mind, but has no leisure to work them out quietly; as far as that goes, I am not much better off!" But he shortly added, "I did Thomson an injustice in supposing him to be wholly immersed in technical work; he was full of speculations as to the original properties of bodies, some of which were very difficult to follow; and, as you know, he will not stop for meals or any other consideration." And indeed Thomson had weighty things in his mind. He was revolving over the speculations which later in the same year he was to pour out in such marvelous abundance in his famous twenty lectures in Baltimore, "On Molecular Dynamics and the Wave Theory of Light." These lectures, delivered to twenty-six hearers, mostly accomplished teachers and professors, were reported verbatim at the time, and reprinted by him with many revisions and additions in 1904. Of this extraordinary work, done at the age of sixty, it is difficult to speak. Day after day he led the twenty-six "coefficients" who sat at his feet, through the mazes of the solid-elastic theory and the spring-shell molecule, newly invented in order to give a conception how the molecules of matter are related to the ether through which light-waves are propagated. All his life he had been endeavoring to discover a rational mechanical explanation for the most recondite phenomena—the mysteries of magnetism, the marvels of electricity, the difficulties of crystallography, the contradictory properties of ether, the anomalies of optics. While Thomson had been seeking to explain electricity and magnetism and light dynamically, or as mechanical properties, if not of matter, at least of ether, Maxwell (the most eminent of his many disciples) had boldly propounded the electromagnetic theory of light, and had drawn all the younger men after him in acceptance of the generalization that the waves of light were essentially electromagnetic displacements in the ether. Thomson had never accepted Maxwell's theory. It is true that in 1888 he gave a nominal adhesion, and in the preface which, in 1893, he wrote to Hertz's "Electric Waves," he himself uses the phrase "the electromagnetic theory of light, or the undulatory theory of magnetic disturbance." But later he withdrew his adhesion, preferring to think of things in his own way.

One characteristic of all Lord Kelvin's teaching was his peculiar fondness for illustrating recondite notions by models. Possibly he derived this habit from Faraday; but he pushed its use far beyond anything prior. He built up chains of spinning gyrostats to show how the rigidity derived from the inertia of rotation might illustrate the property of elasticity. The vortex-atom presented a dynamical picture of an ideal material system. He strung together little balls and beads with sticks and elastic bands to demonstrate crystalline dynamics.

This use of models is indeed to be found in the work of every follower of Faraday. Where Poisson or Laplace saw a mathematical formula, Kelvin with true physical imagination discerned a reality which could be roughly simulated in the concrete. And throughout all his mathematics his grip of the physical reality never left him. According to the standard that Kelvin set before him, it is not sufficient to apply pure analysis to obtain a solution that can be computed. Every equation, "every line of the mathematical process must have a physical meaning, every step in the process must be associated with some intuition, the whole argument must be capable of being conducted in concrete physical terms" In other words, Lord Kelvin, being a highly accomplished mathematician, used his mathematical equipment with supreme ability as a tool; he remained its master and did not become its slave.

Once Lord Kelvin astonished the audience at the Royal Institution by a discourse on "Isoperimetrical Problems," endeavoring to give a popular account of the mathematical process of determining a maximum or minimum, which he illustrated by Dido's task of cutting an ox-hide into strips so as to enclose the largest piece of ground; by Horatious Cocles's prize of the largest plot that a team of oxen could plough in a day; and by the problem of running the shortest railway line between two given points over uneven country. On another occasion he entertained the Royal Society with a discourse on the "Homogeneous Partitioning of Space," in which the fundamental packing of atoms was geometrically treated, affording incidentally the theory of the designing of wall-paper patterns.

To the last Lord Kelvin took an intense interest in the most recent discoveries. Electrons—or "electrions," as he called them—were continually under discussion. He objected, however, in toto to the notion that the atom was capable of division or disintegration.

After taking part in the British Association meeting of 1907 at Leicester, where he entered with surprising activity into the discussions of radioactivity and kindred questions, he went to Aix-les-Bains for change. He had barely reached home at Largs in September when Lady Kelvin was struck down with a paralytic seizure. Lord Kelvin's misery at her helpless condition was intense. He had himself suffered for fifteen years from recurrent attacks of facial neuralgia, and in 1906 underwent a severe operation. Under these afflictions he had visibly aged, and the illness of Lady Kelvin found him little able physically to sustain the anguish of the stroke. He wandered distractedly about the corridors of his house unable at last to concentrate his mind on work in hand. A chill seized him, and after about a fortnight of prostration he sank slowly and quietly away.

He was buried in Westminster Abbey, with national honors, on Dec. 23, 1907.

Kindly-hearted, lovable, modest to a degree almost unbelievable, he carried through life the most intense love of truth and an insatiable desire for the advancement of natural knowledge. Accurate and minute measurement was for him as honorable a mode of advancing knowledge as the most brilliant or recondite speculation. At both ends of the scale his pre-eminence in the quest for truth was unchallenged. If he could himself at the end of his long career describe his own efforts as "failure," it was because of the immensely high ideal which he set before him. "I know," he said on the day of his jubilee, "no more of electric and magnetic force, or of the relation between ether, electricity, and ponderable matter, or of chemical affinity, than I knew and tried to teach to my students in my first session." Yet which of us has not learned much of these things because of his work? We of this institution may well be proud of him—proud that he was one of our first members, that he was thrice our President, and that as our President he died. We shall not look upon his like again.

A RATIONAL DESIGN OF A TOOL-HARDENING ROOM.

By E. F. LAKE.

The Standard Tool Co., of Cleveland, Ohio, has recently built and put into operation an improved plant, as illustrated in this article, for the purpose of heat-treating the twist drills, taps, reamers, milling cutters and various special tools which it manufactures.

The principles on which this room is designed show a great deal of forethought and study and a thorough knowledge of the requirements necessary to produce conditions under which work can be turned out with absolutely uniform results and those that can be repeated from day to day or from year to year. Every detail in the construction has been worked out to aid the operators in their work, not only in making the temperatures easy to judge, but also in taking away the excess heat and foul gases, so that the physical conditions under which the operators work may be pleasant and healthful.

In designing this room, the superintendent and his assistants kept two requisites prominently before them. One was to make the operation of the furnaces such that the temperatures at which the work was hardened and tempered could be standardized and uniform results could be obtained for a given class of work even though months elapse between duplicate orders; the other was to make the conditions under which the men have to work as pleasant as possible.

While this thoughtfulness might be considered as merely philanthropic by some, it was done more in the spirit of justice and gives back practical results to the company, for they are able to obtain a more intelligent class of men and consequently more skill, judgment and ability is shown in the work than would be the case if an undesirable or unhealthy atmosphere was the everyday condition of the room.

VENTILATING ARRANGEMENT.—In the center of the room a sheet-steel chamber incloses the furnaces and their necessary pipes. This is raised a few inches off the floor so that the cool air which comes in through the windows and naturally settles to the floor will pass into the chamber and up through a number of large ventilators in the roof. This insures a continuous circulation of fresh, cool air. The ventilators are located directly above the furnace chamber and between the three stringers running the length of the room, the center one of which acts as a support for the rafters. They are darkened in the same way as the windows, so that light will not penetrate the room and bother the operators in judging colors.

The 22 double windows which are provided on both sides of the room are fitted with iron shutters, opening inside and these are built in such a manner that they baffle all the light, but admit the full volume of fresh air that can pass through the windows when opened to their fullest capacity.

This scheme was adopted for the purpose of giving the operators a uniform light, throughout the day, in which to judge the color of the steel when heated. The light is virtually the same during the entire day regardless of the conditions of light outside the building.

What light is needed is supplied by incandescent lamps inside the long sheet-metal hoods hanging in front of the furnaces. These lamps merely throw a spot of light to the floor and can be moved where they are needed.

FURNACES.—The furnaces are located inside the steel chamber, 10 ft. apart, with a big door in front of each so the operator can go in and adjust them when necessary. Over each furnace is a hood with a branch pipe running up to a main pipe. The main pipe is connected to a fan which sucks the gases and fumes away from the furnaces and blows them into the atmosphere through a chimney which extends above the building.

Both the muffle and radiating type of furnaces are used to heat the metal in. Baths using lead, common salt, metallic salts, potash and other materials are also used. The fuel used for heating in all of these furnaces is natural gas, as a good supply is always obtainable in Cleveland. Two gas mains run through the center of the furnace chamber and are connected to each furnace. One of these acts as a reserve for use in case of any sudden call. The pipe lines running through this chamber which deliver gas, air or water to the furnaces and baths and the one taking the heat and bad air away are each painted different colors, with a wide contrast, such as gray, red, green, etc., so that the line can be easily followed in case adjustments or repairs are necessary.

In the large doors in front of the furnace chamber are openings, directly in front of each furnace opening, through which the work is inserted. These openings are provided with two sliding shutters and the shutters are provided with a small square opening so the work can be seen with the minimum amount of heat coming out into the room to affect the operators.

*Condensed from an article in the "American Machinist," Sept. 3, 1908.

Another opening provided with shutters is near the bottom of the door through which the fuel gas of the furnace can be lighted.

The only heat, therefore, to which the operators are exposed is that which comes through the small openings regulated by shutters, and, as the furnaces for hardening high-speed steels require a temperature so much higher than the others, an electric fan is placed on a bench in front of them to blow the heat coming through the shutters away from the operators.

CONTROL OF TEMPERATURE.—The temperature of the furnaces are controlled by the operators, but these are not left entirely to their judgment, by colors, as each lot of work is accompanied by a chart which is furnished by the foreman of the department.

This chart gives: (1) The correct temperature for the furnace, (2) the length of times that the work should be subjected to this temperature, (3) the materials to be used for the quenching bath, (4) the temperature at which the bath should be maintained, (5) the furnace or bath in which the hardened tools should be drawn and the temperature of the same, (6) the kind of steel and class of work to be hardened; also any other necessary information. The time, date, etc., are filled in by the operator and these charts are filed for future reference and stand as a record by which other work, of a similar nature, can be done at any future time.

A thermo-electric couple is attached to each furnace, which is numbered, and these couples are connected by wire to a clerk's room which is partitioned off by wire screen in one corner of the hardening room.

The apparatus in this room consists of an electric pyrometer, a switchboard in front of it and a recording board above it. At stated intervals the clerk connects the pyrometer to the thermo-electric couple, in the furnace, by the switchboard, which is numbered from 1 to 30 to correspond to the numbers on the furnaces. This gives the temperature of the furnace connected up and if it corresponds to the temperature given on the hardener's chart, described above, nothing is done; but if this temperature varies from that by 5° or more the clerk turns the crank under the number on the indicating board that corresponds to the number on the furnace and raises or lowers the pointer to indicate the number of degrees that the temperature is above or below the standard set. Each line on this board represents 5° and the central line is the standard, or what the furnace should register.

This pointer on the indicator board is connected by wire and pulleys to another indicator at the furnace, so that the furnace operator can see at a glance how the temperature of the furnace must be regulated.

This system makes one pyrometer do for all the furnaces and serves for a check on the hardener. By having a clerk whose special business it is to look after this, the hardener is not interrupted in his work to get pyrometer readings. The clerk also keeps a record of the actions of the furnace so that the conditions under which a given batch of tools is hardened and tempered can always be looked up.

QUENCHING BATHS.—The baths for cooling are located just outside the furnace chamber and close beside the operator. Various materials, such as salt water, glycerin, fish oil, condensed steam, etc., are used for the quenching baths.

The water to supply these baths is forced through a main pipe, running through the center of the furnace chamber, by a pump located just outside the room. From this main it is distributed to the baths. An air pipe also runs to each bath and cool air is forced through a perforated coil in the bottom of each bath. This keeps the liquid agitated, and the heat generated by quenching the hot metal is radiated out through the top. This keeps them always cool, and at frequent intervals a thermometer, which is used in each bath, is pulled out and read to see that the desired temperature is being maintained.

In conjunction with this the solutions (other than plain water) composing some baths are given a circulation by placing a tank above the bath and pumping the liquid into this, then allowing it to flow by gravity into the bath. By this method a bath of large volume can be obtained without the use of an unnecessarily large quenching tank to use up the floor space, and a circulation is obtained which aids greatly in maintaining an even temperature in the bath.

The plain water-quenching baths are given their circulation by the ordinary piping system. Many of the quenching baths, such as the oils, are water-jacketed by placing one tank inside of another. The outside tank, in these, is filled with water which is given a circulation, and the inner tank contains the quenching liquid, which is cooled by air blown through a coil in the bottom as described above.

POWER FOR HARDENING ROOM.—The power equipment for the complete apparatus of the hardening room is located just outside of the hardening room and all of the noise, rattle and vibration of the machinery is kept away from the furnace operators, as there are no moving parts inside the room.

This equipment consists of an exhaust-air blower for sucking the heat and bad air away from the furnaces through the hoods which cover them and the pipes, and delivering it outside the building, an air compressor for giving the air a circulation through the coils in the bottom of the quenching baths, a water pump for giving the necessary water circulation to the various baths and tanks and a dynamo for supplying the room with electricity.

A SEPTIC TANK AND FILTER BED USED FOR RESIDENCES IN THE PHILIPPINE ISLANDS.

By GEO. H. GUERDRUM.*

I desire to submit herewith, as a subject of possible interest to the readers of Engineering News, a drawing of a septic tank which has been developed by this office during the past decade, in the Philippine Islands, for the disposal of house wastes. It will be noted that the construction is extremely simple, yet the action of the micro-organisms is so complete that nearly all solid matter is effectually reduced to liquid form, rendering the removal of sludge from these vaults necessary at only comparatively infrequent intervals; sometimes not oftener than once in from three to five years.

It will be seen that the contents of the flush closets enter the septic tank through the main soil pipe, which for the sake of economy is generally also made to serve as a vent pipe. The custom of submerging this pipe to secure a more thorough top scum has not been adhered to, as it was found that the slight amount of air which followed the sewage into the tank is more of a help than a hindrance to aerobic bacterial action in the septic chamber.

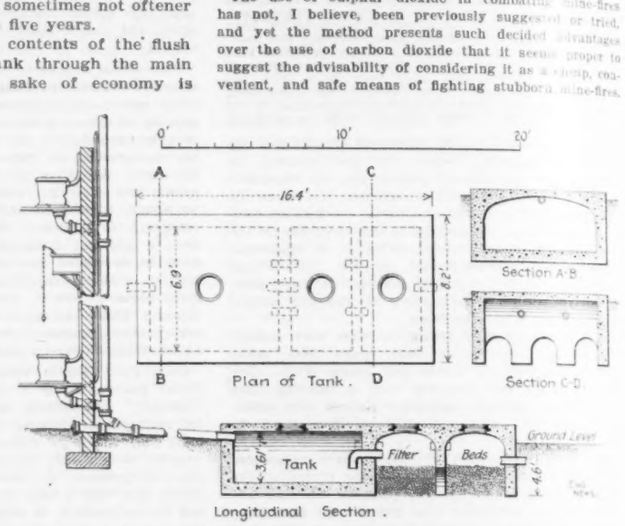
From the septic tank the contents, partly purified, pass through the sumberged iron pipe on to the filter beds. These are what may be called double absorbing filter beds, as there is a concrete baffle in the center, with a final discharge pipe for as much of the purified effluent as is not absorbed by the surrounding ground. In Manila, except in special cases and in outlying districts, all wells and cisterns have been closed, so that the ground may with safety be allowed to absorb as much of the effluent as it will, with the safeguard in this case of a final discharge pipe to prevent the tank from flooding itself. This discharge pipe may be led to the nearest natural drain or street gutter. Three manholes are provided for entrance into each chamber for the purpose of cleaning. The two openings are for the purpose of securing a free circulation of air over the entire surface.

The tank is designed for a private house of from 15 to 20 persons. It may be built of either cut stone or brick laid in cement mortar or of concrete, with a reinforced-concrete three-centered arched top.

This type of vault has done much to lower the death rate of Manila during the past few years, and has been a useful temporary expedient for the disposal of sewage, pending the construction of a sanitary or separate sewer system for the city. Upon the completion of this sewer system, which is now only a question of months, these tanks will have served their purpose, as the house drainage will then be allowed to discharge directly into the sewers and the sewage disposal will be handled by the municipality.

In view of the still all-too-prevalent custom of many of the smaller cities and towns of the United States of constructing their water-works systems many years in advance of adequate sewerage facilities, this design is submitted as a possible means of individual house-sewage purification before it is allowed to enter the streams and waterways of the vicinity.

*Chief, Division of Sanitary Engineering, Bureau of Health for the Philippine Islands.



SEPTIC TANK AND FILTER BED FOR RESIDENCE, PHILIPPINE ISLANDS.

SULPHUR DIOXIDE AS AN AGENT IN FIGHTING MINE-FIRES.*

By WALTER O. SNELLING,† M. Am. Inst. M. E.

In combating mine-fires the use of carbon dioxide as a means of producing an atmosphere in which combustion cannot be sustained, has been many times suggested and frequently tried, generally with a fair degree of success. The carbon dioxide is produced by acting on limestone with dilute sulphuric acid, large wooden boxes being used to hold the limestone, and are arranged in such a manner that one box may be cleaned and refilled with blocks of limestone while another is being used in generating the carbon dioxide. The gas is conducted by means of pipes of large diameter to the location of the fire, tight brattices having been previously put up as close to the fire as possible on every side, so as to limit the space to be filled with the gas to the smallest possible volume. The cost of producing carbon dioxide has been, however, a decided draw-back to the use of this method, and the danger of producing carbon monoxide by the reduction of the carbon dioxide by heated carbon, and consequently bringing about an explosion, has also tended to prevent the application of this method.

The use of sulphur dioxide in combating mine-fires has not, I believe, been previously suggested or tried, and yet the method presents such decided advantages over the use of carbon dioxide that it seems proper to suggest the advisability of considering it as a cheap, convenient, and safe means of fighting stubborn mine-fires.

COST, PREPARATION, ETC.—One ton of brimstone, costing from $20 to $30, will produce about 25,000 cu. ft. of sulphur dioxide gas, and allowing for all sources of loss it is probable that sulphur dioxide gas can be produced for about $1,300 per 1,000,000 cu. ft. For carbon dioxide gas, produced by the action of sulphuric acid on limestone, a good estimate would be $4,000 per 1,000,000 cu. ft., provided that sulphuric acid and limestone could be obtained at a small cost. Even under these favorable conditions it will be seen that carbon dioxide is about three times as costly as sulphur dioxide, and under ordinary conditions the advantages on the side of sulphur dioxide would be much more marked.

EFFICIENCY.—Sulphur dioxide is more efficient than carbon dioxide in putting out fire. No combustible material can possibly burn in an atmosphere containing any considerable quantity of sulphur dioxide. Sulphur dioxide is very heavy, being almost twice as heavy as carbon dioxide (1 cu. ft. weighing 81 grams, while 1 cu. ft. of carbon dioxide weighs 56 grams), and this heavier weight of the sulphur dioxide is an element which leads to increased efficiency, since the readiness with which the air present in the interstices of a pile of burning coal will be displaced by any inert gas is dependent upon the density of the gas. Another important effect of the greater density of sulphur dioxide is that its cooling effect upon a bed of incandescent coal is greater, volume for volume, than would be the case with a less dense gas.

SAFETY.—None of the dangers incident to the use of carbon dioxide are present with sulphur dioxide. No explosive lower oxides can be produced by the reduction of sulphur dioxide. Still more important, the danger always present when using carbon dioxide, of men getting into the gas without knowing of its presence, and suffocating, is absent when sulphur dioxide is used, since its strong odor gives instant warning when but a small fraction of 1% of the gas is present in the air.

OTHER ADVANTAGES.—Any leakage of carbon dioxide from a mine can only with great difficulty be detected. Any leakage of sulphur dioxide would quickly make itself

*A paper presented at the New York meeting of the American Institute of Mining Engineers, February, 1908.
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known that the openings could accordingly be closed before more than a small portion of the gas had escaped.

The use of oxygen-helmets as emergency apparatus in mines is believed to be increasing in the United States. Most forms of rescue-masks can be worn in an atmosphere of sulphur dioxide, so it is possible to know definitely when the fire is extinguished, and when it is safe to turn in the fresh air. But when the sulphur dioxide method has not been used, the large amount of carbon monoxide present is likely to be a source of danger to the person wearing the helmet, since it is an interesting fact that some of the simpler patterns of rescue-helmets which may be worn with safety in an atmosphere of sulphur dioxide are found to be but little protection when worn in an atmosphere containing much carbon monoxide. The reason for this is not clear, but it is most probably due to the greater permeability to carbon monoxide of the leather or other fabric of which the rescue-mask is made, the lighter carbon monoxide passing through the fabric with greater readiness than most other gases.

CONCLUSION.—The extremely simple manner in which sulphur dioxide can be produced, the cheapness of the method, and the efficiency of the gas in putting out fires, seem to make this a desirable means of combating mine fires. The safety of the method, its convenience, and its utility in showing fissures which allow escape of gas and ingress of air, are also strong points in its favor. The following comparison of the physical properties and cost of producing sulphur dioxide and carbon dioxide will be of interest.

	Sulphur dioxide.	Carbon dioxide.
Molecular mass.....	64.	44.
Mass of 1 liter.....	2.87 grams.	1.97 grams.
1 cu. ft. weighs.....	81.13 grams.	55.78 grams.
1,000 cu. ft. weighs...	178.48 lb.	122.71 lb.
1,000 cu. ft. requires..	89.24 lb. sulphur.	{ 300 lb. HSO. { 296 lb. CaCO.
Cost materials per 1,000 cu. ft.	$1.35	$4.00
Cost of 1,000,000 cu. ft...	$1,350.00	$4,000.00

AN EXPLOSION OF GAS in factory No. 2 of the Pittsburgh Plate Glass Co., at Tarentum, Pa., Oct. 4, started a fire which destroyed one-half of the plant. The company owns and operates its own gas wells and had recently put three new ones in operation. The consequent increase of pressure in the mains is thought to have caused a leak at one of the joints in the main near the polishing house. The polishing and plaster houses were filled with gas from this leak, and the explosion quickly followed. The greater part of the loss, which is estimated at $500,000, was suffered in the polishing department, where 32 polishing machines and 2,000 ft. of silvered glass for mirrors were destroyed.

AN EXCURSION TRAIN on the Toledo & Ohio Central Ry. was wrecked at Sugar Ridge, Ohio, Oct. 1. Four persons were killed and ten injured. The train, made up of seven coaches, was running slowly from Bowling Green to Sugar Ridge, the first stop, to enable the conductor to collect all the fares. A fast freight, which left Bowling Green ten minutes behind the excursion train, overtook it as it was entering Sugar Ridge and crashed into the rear car. This car was reduced to splinters and the one next to it was overturned. Two other cars were derailed. Those killed were in the second car from the rear. The last car was a combination smoker and was empty and unlighted. It is believed that there were no lights on the rear of the train.

THE 20TH CENTURY LIMITED, of the New York Central system, was partially derailed Oct. 2 while running through Gary, Ind., over the Lake Shore & Michigan Southern Ry., at the rate of 60 mi. per hr. The accident was caused by the dropping down of a part of the air-brake mechanism beneath the dining car. This car and the smoker left the tracks.

A HEAD-ON COLLISION between a work train and a freight took place Oct. 1 on the Central New England Ry., 15 miles northeast of Poughkeepsie, N. Y. The trains met on a curve while the work train was running at 30 mi. per hr. Three men were killed and seven injured.

A FLOOD IN INDIA Sept. 29 was accompanied by tremendous loss of life, variously estimated at from 10,000 to 50,000. The flood was the result of unusually heavy rainfalls in the vicinity of Hyderabad, the capitol of the Nizam's Dominions. A large lake or reservoir communicating with the River Musi burst its banks, causing the river to rise 60 ft. A village of 1,000 houses was reported as being engulfed in mud after the subsidence of the water. The native hospital at Hyderabad was undermined by the water and collapsed, burying the inmates in the wreckage. The work of recovering the bodies, many of which are said to be lodged in the branches of trees, is being carried on with the help of elephants. The air for miles is polluted by the odor of unburied victims.

GOVERNMENT DAM NO. 13 ON THE OHIO RIVER at McMechen, six miles south of Wheeling, W. Va., was the scene of an accident Oct. 5 which resulted in the death of two workmen. A portion of the falsework gave way permitting the caving in of a large body of gravel which buried the two men to a depth of 25 ft. The dam has been under construction four years and the contract calls for its completion the coming winter.

THE POWER STATION AT CHELSEA, ENGLAND, which supplies the current for the London Tubes was disabled on the afternoon of Oct. 3 by the explosion of a steam turbine. Many trains were brought to a standstill in the tunnel, and the passengers were obliged to grope their way to the nearest stations in the darkness. Traffic was resumed in the evening of the same day.

PANAMA CANAL EXCAVATION during September totaled 3,158,886 cu. yds., a daily average for the 25 working days of 126,355, as against a total of 3,252,506 cu. yds. for August, a daily average of 125,096 for the 26 working days. The record for the past two months is as follows:

Steam Shovels:	September.	August.
Atlantic division	136,892	146,572
Central division	1,442,567	1,499,963
Pacific division	135,536	129,945
Dredging:		
Atlantic division	624,776	638,217
Pacific division	750,080	737,774
Canal prism total.....	3,089,851	3,152,471
Accessory works outside canal prism:		
By steam shovel	68,451	98,646
By hand	584	1,389
Total excavation.....	3,158,886	3,252,506

The rainfall during September was 9.72 ins.; during August, 11.93 ins.

A LARGE COASTING STEAMER, the "Brazos" has just been put in service on the Mallory Line, between New York and Galveston, Tex. This steamship is one of the largest and fastest boats in the coastwise trade, approaching in size and appointments the largest of the transoceanic vessels. She is 415 ft. long, with a beam of 54 ft. and a depth of 37 ft. and displaces 9,800 tons. The engine equipment consists of two vertical quadruple engines, capable of developing a speed of 16 knots.

AN AIMING DEVICE FOR HEAVY GUNS on warships is being built at Cambridge, Mass., for the U. S. Navy Department. The device makes possible a "continuous aim," enabling the gunners to keep their guns trained on a moving target in spite of the rolling of the ship. The movement of the guns in a vertical plane on their trunnions and the rotation of the turrets are effected by means of electric motors equipped with a new hydraulic transmission which permits a very delicate control of the speed. Two battleships have been already supplied with this device, and it has been partially installed on eight other vessels.

A NEW BRITISH PATENT ACT, which came into effect on Aug. 28, 1908, provides that holders of British patents, who do not begin the actual manufacture in Great Britain of the articles on which they hold patents, are liable to forfeiture. The forfeiture is not automatic, it appears, but may be made effective by revocation by the Board of Trade on complaint of any interested person.

LOCOMOTIVE SPARKS have been held responsible for recent forest fires in New York State. The Public Service Commission of the Second District has summoned 18 railways, operating in the Adirondacks and the Catskills, to appear before it at Albany on Oct. 18, to show (1) the precautions they are now using against the causing of fires in forests, and (2) why they should not use a non-sparking fuel or else adopt some other motive power than steam. This action has been taken in accordance with a law passed by the New York State Legislature during the present year, authorizing the Public Service Commission, on request of the Forest, Fish and Game Commissioner, to notify railways passing through forest lands, in counties containing forest preserves, to adopt devices to protect the forests against fires likely to be set by railway operations. It is stated that the Forest Commissioner has reported that 90% of the recent forest fires in New York State were started by locomotive sparks.

PAYING FOR RAPID TRANSIT LINES in New York City by the proceeds of assessments on the property benefited is advocated in a communication addressed by the City Club of New York (55 West 44th St.) to the Board of Estimate and Apportionment of New York City and the Public Service Commission of the First District of the State of New York. Memoranda submitted by the club show by amounts and percentages how property specially benefited by rapid transit facilities increased in value from 1900 to 1907. It is urged that these property increases in many sections are sufficient to pay the entire cost of transit improvements and still leave a large margin of increased value for the property owners. It is suggested that legislation might readily be secured which would make this scheme legally possible.

ELECTRIC TRACTION for the Chicago suburban service of the Illinois Central R. R., is again being considered by that railway. This course is in part due to the very strong public agitation against the smoke, cinders and noise of the steam locomotives. The line passes through residential districts, and under the conditions of quick service and frequent stops and starts it seems impossible to avoid the throwing of showers of cinders from the smokestacks, due to the sharp exhaust. The main line passenger and freight trains add somewhat to the trouble, but the suburban trains are the worst offenders and are of course the most numerous. Whether the main-line traffic would also be operated by electric traction, or whether it would be sufficient to deal with the suburban traffic only is one of the many questions to be considered. The matter was very fully investigated several years ago by Mr. John F. Wallace, and has been revived at various times. At present, the railway company is reported to be making another thorough study, but financial conditions are not considered favorable for any action being taken in the near future.

COAL AND OIL RECORDS OF LOCOMOTIVES are published monthly by the Louisville & Nashville Ry., comparing the results with those of the same month in the previous year. Some of the figures for July, 1908, are given below:

	Pass.	Freight.	Switch.	Total or average.
No. of locomotives in service	138	363	120	674
Ave. mileage per engine	5,283	3,577	3,143	3,749
Miles per pint of lub. oil	25.52	20.05	38.37	23.46
Miles per pint of valve oil	93.18	54.89	65.71	64.81
Cost of valve and lub. oil per 100 mi., cts.	20.46	29.92	16.86	24.77
Coal per mile, lbs.....	103.72	173.91	87.39	136.84

SAND AND STONE SCREENINGS FOR CONCRETE, and particularly their relative merits for cement sidewalks, have been under discussion by the City Council of Chicago. A number of reports and letters from engineers who have successfully used screenings, and have found the concrete stronger and better than that made with sand, were presented in evidence, as were also copies of articles in Engineering News having reference to this subject. The bulk of the evidence was strongly in favor of screenings for concrete in large masses, but there was very little definite evidence or information in regard to sidewalk work. Some statements were made objecting to limestone screenings as being too dusty or too soft. Some of the parties applied to for information replied that while they had never used anything but sand they did not consider anything else could be better. The paving inspectors reported generally in favor of sand, with which they are more familiar. One objection urged against the screenings was that the material as obtained commercially contains a considerable amount of dust and decomposed or rotten stone, due partly to exposure. On the other hand, it was pointed out that sand may be dirty also, and that there should be little difficulty in controlling the quality of the material supplied, whether sand or screenings. This view was taken by the council, which by a large majority adopted an order requiring the Board of Local Improvements to admit screenings in competition with sand for work of this kind. Both materials were formerly allowed, but some time ago the Board limited its specifications to the use of sand in sidewalk concrete.

A CENSUS OF THE WATER POWER OF THE United States is to be taken by the U. S. Geological Survey, in connection with the researches of the Conservation Commission. The census will be apportioned among nine hydrographic district engineers of the Survey.

TREE PLANTING ON ABANDONED NEW ENGLAND FARMS.—Corporations and private citizens throughout New England are beginning to realize the opportunities which this region offers for profitable forest planting. This year about 2,500 acres have been planted in the six New England States by private citizens. In addition, a number of water companies have adopted a forest policy. The largest plantation of this character, which comprises over 1,000 acres, belongs to the Metropolitan Water and Sewerage Board [and are located at], Clinton, Mass.

One of the most important phases of reforestation in New England is that of planting abandoned farms and other waste land, which at present is bringing no income. In Massachusetts this waste land amounts to 10% of the total area of the state, while the latest reports in Rhode Island show 228 abandoned farms. It is this type of land which is now being planted. Wealthy men here see a good investment, and a number of them have planted tracts of at least 50 acres each this year, with the intention of increasing the size of the plantations annually. One owner in Massachusetts who started

a white pine plantation of 63 acres this year, expects to plant 50 acres annually for the next ten years, while others intend to plant tracts of various sizes ranging upwards to 200 acres apiece next spring.

White pine is, of course, the species most generally planted, but other species which make excellent growth and are being used more and more are Norway spruce, for timber and pulp-wood chestnut, for telegraph poles, posts, ties and lumber; red oak, for piles and ties; black locust, for fence posts, and sugar maple for a variety of products.

It is not only on these tracts of waste land that planting is beginning to play such an important part. The practical farmer in this region now realizes that the cheapest and best way to get the special wood products which he needs on his farm, is by planting the trees. He realizes, too, the protective value of plantations which serve as shelterbelts and windbreaks. Altogether, this region offers excellent opportunities for tree planting.—U. S. Forest Service.

A PECULIAR ATTITUDE TOWARD REINFORCED concrete is being maintained by the British Local Government Board, a body which supervises all municipal construction work in England, and without the consent of which no city can undertake any local improvement. The Board refuses to grant to municipal authorities the same period for the repayment of loans on reinforced-concrete structures as it grants for stone, brick, steel, or, what is more strange, for concrete unreinforced. For a concrete building a loan period of 30 years is allowed, but for one of reinforced concrete, the period granted is only 15 years, thus imposing a higher tax-rate on those cities which wish to build in the latter material. Many engineers and technical associations have petitioned the Board to change its ruling, pointing out not only the faulty theory, but also the inconsistency of its action, but so far the matter stands as at first ruled.

THE MUNICIPAL WATER-SUPPLY SCHEME FOR San Francisco seems to be making progress. Mr. Marsden Manson, City Engineer, has made a report in which he estimates that 60,000,000 gals. per day can be brought from the Sierra at a cost of about $31,000,000 and that a distributing plant could be built for about $12,000,000 in addition. As an alternative the city might purchase the present works owned by the Spring Valley Water Co. Assuming that these works would cost $32,000,000 and would have to be reinforced by an additional supply, this scheme would finally cost the city about $51,000,000. It is stated that the board of supervisors will call an election at which the people will vote on accepting a grant of water rights in the Sierra from the Federal Government, the vote also to pass on a $600,000 bond issue to secure certain necessary private holdings in the same section.

A 25-WATT TUNGSTEN incandescent electric lamp has been placed on the market by Edison Lamp Works of the General Electric Co., Harrison, N. J. This lamp is the latest development in a type of metallic-filament lamps described in Engineering News, July 25, 1907. The new lamp is designed for 100 to 125-volt circuits and would be rated at about 20 c. p. It is designed to be used in place of 16-c. p. lamps on direct or alternating current circuits and may be lighted in any position.

PERSONALS.

Mr. J. W. Ryan has become Superintendent of the Salt Lake & Ogden Ry., succeeding Mr. A. D. Pierson.

Mr. H. D. Parish has been appointed General Superintendent of the Jamestown, Chautauqua & Lake Erie Ry.

Mr. J. H. O'Brien, Master Car Builder of the Mexican Central Ry. has resigned. His successor is Mr. C. W. Tessier.

Mr. J. A. J. Shultz, President of the Shultz Belting Co., has been elected President of the Missouri Manufacturers' Association.

Mr. L. W. Miller, Engineer of Maintenance of Way of the Chihuahua Division of the Mexican Central Ry., has been transferred to the Mexico division.

Mr. A. H. Powell, Master Mechanic of the Rio Grande Western Ry., at Grand Junction, Colo., has been transferred to Salt Lake City to succeed Mr. A. H. Gairns.

Col. W. H. Bixby, M. Am. Soc. C. E., Corps of Engineers, U. S. Army, who has been at Chicago for some time has been transferred to the U. S. Engineer Office at St. Louis, Mo.

Mr. J. T. Arundel, Superintendent of the Pacific division of the Canadian Pacific Ry., at Vancouver, B. C., has been appointed General Superintendent with headquarters at Winnipeg, Man.

Mr. A. E. Welby, General Superintendent of the Denver & Rio Grande R. R., has been appointed Vice-President and General Manager of the Denver, Laramie & Northwestern R. R., now under construction.

Mr. E. A. Theed, Assistant Division Superintendent of the Lake Shore & Michigan Southern Ry., at Cleveland, Ohio, has become Assistant Superintendent of the Michigan division, succeeding Mr. T. J. Dawson at Elkhart, Ind.

Mr. L. B. Marks, M. Am. Inst. E. E., and Mr. J. E. Woodwell, Assoc. Am. Inst. E. E., have opened offices as consulting mechanical, electrical and illuminating engineers in the Terminal Bldg., 41st St. and Park Ave., New York.

Mr. F. W. Scarborough, M. Am. Soc. C. E., and Mr. C. K. Howell have associated themselves under the corporate name of Scarborough & Howell, Inc., for the practice of architecture and engineering. Their office is at Richmond, Va.

Mr. Francis W. Hoadley, who was for many years in charge of the business office of the American Society of Mechanical Engineers, has been elected Secretary and Treasurer of the Cassier Magazine Co., with offices at 12 West 31st St., New York City.

Mr. Albert T. Goldbeck has been appointed an instructor in civil engineering at Lafayette College, and Mr. R. W. Thoroughgood has become an instructor in surveying and railway engineering. Mr. Goldbeck graduated at the University of Pennsylvania in 1906.

Mr. L. J. Polk, Vice-President and General Manager of the Stephensville, North & South Texas Ry., has resigned to devote his whole time to his interests in the Ravia, Granite & Ballast Co. Mr. Polk's duties as Vice-President and General Manager have been assumed by Mr. B. C. Cage, President.

Mr. R. H. Ingram, General Superintendent of the southern district of the Southern Pacific Co., has resigned. He will be succeeded by Mr. H. V. Platt, Superintendent of the Los Angeles division. Mr. W. H. Averell, Superintendent of the Tucson division, will succeed Mr. Platt at Los Angeles.

Maj. Thos. H. Rees, Corps of Engineers, U. S. Army, has been appointed to take charge of the U. S. Engineer Office at Chicago, succeeding Col. W. H. Bixby, who has been transferred to St. Louis. Maj. Rees will have charge of the river and harbor improvements of Chicago, Calumet, Michigan City, and all intermediate points along the lake front of Lake Michigan.

Mr. F. G. Frink, Assoc. M. Am. Soc. C. E., has been appointed Professor of Railway Engineering at the University of Oregon. Mr. Frink is a graduate of the University of Michigan and University of Chicago, and has previously taught as Assistant Professor of Civil Engineering at the University of Illinois and as Professor of Civil Engineering at the University of Idaho.

Obituary.

John W. Mute, President of the St. Louis Car Wheel Co., died Oct. 5 at his summer home near Portland, Me., aged 47 years.

Alfred Stone, member of the Executive Committee of the National Fire Protection Association, died at Peterboro, N. H., Sept. 4.

William G. Elliott, Managing Director of the Ontario Portland Cement Co., died Sept. 13 at Brantford, Ont., at the age of 44 years. His death was the result of a stroke of paralysis.

William H. Bailey, M. Am. Soc. M. E., New York Agent of the American Tube Works of Boston, died Oct. 4 at his home in New York City at the age of 75 years. Mr. Bailey was an Associate of the Society of Naval Architects and Marine Engineers and a member of the Engineers' Club and the National Academy of Design.

John Baxter Hoover, U. S. Naval Constructor, retired, died at his home in Elizabeth, N. J., Sept. 29. Mr. Hoover was born in Pennsylvania in 1836. He entered the naval service in 1875, became a naval constructor in 1888, and was retired upon reaching the age of 62 years, in 1898. He had charge of the construction of the first U. S. battleship "Maine," which was blown up in Cuban waters, and he was connected with the court of inquiry sent to ascertain the cause of the ship's destruction.

William Keuffel, President of the well-known firm of Keuffel & Esser, died at his home in Hoboken, N. J., Oct. 1. Mr. Keuffel was born at Walbeck, Germany, in 1838, and received his education in the public and private schools of his birthplace. At the age of 15 he left school and became an apprentice in a general merchandise store where he remained for four years, receiving a severe but thorough mercantile and business training. He next entered the employ of a large hardware house in Hanover, Germany. Several years later he went to Birmingham, England. He came to the United States in 1866 and, in the following year, together with his friend, Hermann Esser, founded the firm of Keuffel & Esser, the first in this country devoted exclusively to supplying the requirements in office and field of the surveyor, engineer, architect and draftsman. Mr. Keuffel has been a resident of Hoboken almost from the day he landed in America. He was for many years President of the Hoboken Academy, a German-American school, and was a member of the Technischer Verein.

ENGINEERING SOCIETIES.

COMING MEETINGS.

AMERICAN STREET AND INTERURBAN RAILWAY ASSOCIATION.
Oct. 12-16. Annual convention at Atlantic City, N. J.
Secy., B. V. Swenson, 29 West 39th St., New York City.

RAILWAY SIGNAL ASSOCIATION.
Oct. 13-15. Annual meeting at Washington, D. C.
Secy., C. C. Rosenberg, 12 North Lincoln St., Bethlehem, Pa.

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS.
Oct. 20-22. Annual convention at Washington, D. C.
Secy., S. P. Patterson, Boston & Maine R. R., Concord, N. H.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 20-23. Annual meeting at Atlantic City, N. J.
Secy., A. P. Folwell, 239 West 39th St., New York City.

AMERICAN GAS INSTITUTE.
Oct. 21-23. Annual meeting at New York City.
Secy., W. Bissell, 29 West 39th St., New York City.

AMERICAN ELECTROCHEMICAL SOCIETY.
Oct. 30-31. Fall meeting at New York City.
Dr. J. W. Richards, Bethlehem, Pa. Secy.,

ROADMASTERS AND MAINTENANCE-OF-WAY ASSOCIATION OF AMERICA.
Nov. 10-12. Annual meeting at Milwaukee, Wis.
Secy., W. E. Emery, West Chicago, Ill.

AMERICAN RAILWAY ASSOCIATION.
Nov. 18. Annual meeting at Chicago, Ill. Secy., W. F. Allen, 24 Park Pl., New York City.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Nov. 19-20. Annual meeting at New York City. Secy., W. J. Baxter, 29 West 39th St., New York City.

AMERICAN INSTITUTE OF ARCHITECTS.
Dec. 15-17. Annual convention at Washington, D. C.
Secy., Glenn Brown, "The Octagon," Washington, D. C.

THE CORNELL SOCIETY OF CIVIL ENGINEERS.—The regular yearly meeting for the election of officers will be held at 7 p. m., Oct. 20, 1908, at Kalil's Restaurant, 16 Park Place, New York City.

BROOKLYN ENGINEERS' CLUB.—At the meeting to be held in Brooklyn, N. Y., Oct. 8, Mr. Herbert C. Keith, M. Am. Soc. C. E., will present a paper, entitled "Some Features of the Bridges of the Harlem River Branch, New York, New Haven & Hartford Railroad."

AMERICAN ELECTROCHEMICAL SOCIETY.—The preliminary program for the annual meeting at New York City, Oct. 30 and 31, calls for professional sessions at the Chemistry Building, College of the City of New York, at 9 a. m. and 2 p. m., Oct. 30, and at 9 a. m., Oct. 31, at the Chemists' Club, 108 West 55th St. In addition there will be lunches, a subscription dinner (Oct. 30), an excursion and a smoker. Prof. J. W. Richards, of Lehigh University, South Bethlehem, Pa., is Secretary.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—The Toronto Section opened the fall course of meetings Sept. 19, 1908, with an excursion to Niagara Falls, Ont. The generating and transformer stations of the Electrical Development Co. of Ontario, the Canadian-Niagara Power Co. and the Ontario Power Co. were visited. It was noted that there has been a very rapid growth of the power load delivered by these three generating stations and that a large share of this load is going to points in Ontario, particularly Toronto and Welland.

AMERICAN GAS INSTITUTE.—At the third annual meeting at New York, Oct. 21-23, the following papers will be read: "High Pressure Distribution," Jacob D. von Maur, St. Louis, Mo.; "Benzol Enrichment," E. H. Earnshaw, Newark, N. J.; "Some Further Remarks on the Photometry of Gas," Chas. O. Bond, Philadelphia; "Physical Theory of Coal Carbonization," W. H. Fulweiler, Philadelphia; "Vertical Retorts," J. H. Taussig, Philadelphia; "Relative Merits of Wrought Iron and Steel Pipe," Frank N. Speller, Pittsburg; "Report of Progress on 'A' Meters," W. J. Serrill, Philadelphia; "Report of Progress on Dipping Meters," W. A. Castor, Philadelphia; "Holder Cups and Tank Heating," C. J. Ramsburg, Philadelphia; "Better Gas Illumination," Thomas J. Litle, Jr., Gloucester, N. J.

THE NATIONAL ASSOCIATION OF COTTON MANUFACTURERS.—At the semi-annual meeting of Sept. 29-30 at Saratoga Springs, Mr. Lewis Sanders of New York City presented a paper entitled "The Textile Mill Power Plant," which treats of design and management and the precautions to be observed in making improvements or alterations. The results of an extensive test of a mill power plant are given, including tables showing distribution of costs, losses and power and comparative unit costs of operation for the three separate boiler plants. Mr. Sanders advocates a separate office organization for the power plants of large mills, and discusses the advisability of schools of instruction for firemen and engineers and of automatic recording instruments to keep a check on their efficiency. Such instruments and elaborate systems should not be installed unless the records are to be carefully studied and acted upon promptly. In an appendix to the paper is given a list of the items to be recorded in the boiler-room records and a table of premiums for firemen.

CONSTRUCTION NEWS

Supplement to ENGINEERING NEWS. New York, October 8, 1908.

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CONSTRUCTION NEWS.

PLANS AND SPECIFICATIONS ON FILE.

(denotes that this work is advertised in Engineering News.)*

The following Plans (P.) and Specifications (S.) are on file and may be seen at the office of The Engineering News Publishing Co., 220 Broadway, New York.

Bids close.	Work.	Place.	See issue.
At once.	Court-house	Houston, Tex. (P. & S.)	10- 8
10- 9*	Wharf, seawall	Mobile, Ala. (S.)	9-10
10-10*	Steel stack, boilers	Boston Mass. (S.)	9-17
10-12*	Superstructure	Cincinnati, Ohio (P. & S.)	9-17
10-12	Roadway, etc., Ft Thomas, Ky.	(P. & S.)	10- 8
10-14	Bridge, Phila., Pa.	(P. & S.)	10- 8
10-17	Wharf and dredging, Norfolk, Va.	(S.)	10- 1
11-17*	Lock and dam, Mobile, Ala.	(P. & S.)	9-17
10-19*	Engine, Houston, Tex.	(S.)	9-17
10-28*	Sewers, Rye, N. Y.	(P. & S.)	9-24
10-30	Pipe, Passaic, N. J.	(S.)	10-17
12- 1	Dredging, Hawaii	(S.)	9-17

LIST OF CONTRACTS PENDING.

LIGHT, HEAT AND POWER PLANTS.

10- 9 Producer pl., Salt Lake City, U. 10- 1
10-12 Elec. trolley system, New York.. 10- 1
10-12 Elec. equipment, Los Angeles, Cal. 10- 8
10-14 Lamps, Wash., D. C..... 10- 8
10-15 Light fixtures, New York..... 10- 8
10-16 Elec. equipment, Soldiers' Home, Cal. 10- 8
10-17 Lighting fixtures, Wash., D. C.... 9-24
10-19* Wiring, etc., Ft. Monroe, Va.... 10- 1
10-19 Light fixtures, New York 10- 8

BRIDGES.

10- 9 Bridge, Cincinnati, Ohio 9-17
10- 9 Bridge, Madisonville, Ohio..... 9-24
10- 9 Bridges, Manhattan, Kan..... 9-24
10- 9 Bridges, Brookville, Ind..... 10- 1
10-12 Bridge, Los Angeles, Cal..... 10- 8
10-12 Bridge, Everett, Wash..... 10- 8
10-12* Superstructure, Cincinnati, Ohio. 9-17
10-12 Bridge, Princeton, Ind. 10- 1
10-13 Culverts, Kansas City, Mo..... 10- 8
10-14 Bridge, Philadelphia, Pa..... 10- 8
10-15 Bridges, Muskogee, Okla..... 10- 8
10-15 Bridge, Sioux Falls, S. Dak.... 10- 8
10-15 Arches, etc., Salem, Ind..... 10- 8
10-17 Bridge, Amanda, Ohio 10- 1
10-19 Bridge, Taylorsville, Ohio..... 10- 8
10-22 Bridges, etc., Indianapolis, Ind.. 10- 8
10-26 Abutments, etc., Byesville, Ohio. 10- 8
10-26 Bridge, Barstow, Cal..... 10- 1
10-27 Bridge, Portsmouth, Ohio..... 10- 8
11- 7 Bridges, Frankfort, Ind..... 10- 8

BUILDINGS.

At once. Court-house, Houston, Tex.... 10- 8
10- 9 Quarters, Ft. Howard, Md..... 9-17
10-10 Post-office, Butte, Mont..... 8-20
10-10 Walls, etc., Paris, Ill..... 9-24
10-10 Building, Birmingham, Ala..... 9-24
10-12 Fire-house, Hartford, Conn..... 10- 8
10-14 Fire escape, veranda, New York. 10- 8
10-14 Stable, Ft. Leavenworth, Kan... 10- 8
10-14 Steel, Atlanta, Ga..... 10- 1
10-15 Copper work, Atlanta, Ga..... 10- 1
10-15 Post-office, Marietta, Ohio..... 9-24
10-15* Quarters, Ft. Andrews, Mass..... 9-17
10-15 Repair shop supplies, New York (Mfg. Pl) 10- 8
10-15 Elevator, New York 10- 8
10-16 Armory, New York 10- 8
10-16* Plaza impvts., Wash., D. C.... 10- 8
10-17 Court-house, Boston, Mass..... 9-10
10-19* Post-office, Porto Rico..... 9- 3
10-20 Prison, New York 10- 8
10-20 Hospital, Elgin, Ill..... 10- 8
10-21 Engineering bldg., Ann Arbor, Mich. 10- 1
10-22 Mech. equip., Philadelphia, Pa... 10- 8
10-23 Quarters, Ft. Du Pont, Del. 10- 1
10-26 Refrigerating plant, Leavenworth, Kan. (Mfg. Pl.) 10- 8
10-28 School plans, Lynn, Mass..... 10- 1
10-30* Post-office, Carthage, Mo..... 9-24
11- 1 School, Wilkinburg, Pa..... 9-10
11- 2* City Hall, Chicago, Ill..... 10- 8
11- 2 Plans, Indianapolis, Ind..... 10- 8
11- 4* Post-office, Marietta, Ga..... 10- 8
11- 4 Buildings, No. Chicago, Ill..... 10- 1
11- 5* Interior work, Cleveland, O..... 10- 1
11- 7 Post-office, Eugene, Ore..... 10- 8
11- 9 Tower, St. Paul, Minn..... 10- 8

WATER-WORKS.

10- 8 Pumping station, Cleveland, O.. 10- 8
10- 9 Well, Clarksdale, Miss..... 10- 8
10-10 Tower, Albo, Mo..... 10- 8
10-12 Water pipe, etc., Reading, Ohio.. 10- 8
10-12 Air Compressor, Dayton, Ohio... 10- 8
10-12* Filtration plant, Evansville, Ind. 9- 3
10-12 Water-works, Burlington, Colo.. 10- 1
10-14* Water supply, Kings Park, N. Y. 10- 1
10-14 Cast-iron pipe, etc., Vancouver, B. C. 8-13
10-14 Water-pipe, Chagrin Falls, Ohio.. 9-17
10-14 Pumping plant, Richmond, Va... 10- 8
10-15 Pumping sta., Brownwood, Tex.. 10- 1
10-19 Water-works, Oakland, Md..... 10- 1
10-19* Engine Houston, Tex..... 9-17
10-19 Water conduit, Syracuse, N. Y.. 10- 8
10-20 Well, Lower Brule, S. Dak..... 10- 8
10-21 Meter tube, Camden, N. J..... 10- 8
10-26 Water meters, Victoria, B. C.... 10- 8
10-29* Water-works, Helena, Mont..... 10- 8
10-30 Water pipe, etc., Passaic, N. J.... 9-17

SEWERS.

10- 9* Sewer, Louisville, Ky..... 9-24
10- 9 Sewers, New Haven, Conn..... 10- 8
10- 9 Pipe sewers, Salt Lake City, Utah. 10- 1
10-10 Sewer, Adams, Minn 10- 1
10-12 Sewer, Wabash, Ind 10- 1
10-12 Sewer, Jefferson, O 10- 1
10-12 Sewers, Steubenville, Ohio..... 10- 8
10-12 Sewage, Circleville, Ohio..... 10- 8
10-12 Sewer, Washington, D. C..... 10- 8
10-13 Sewers, Springfield, Minn..... 10- 8
10-13 Sewers, Hilldale, Mich..... 10- 8
10-13 Sewers, Cleveland, Ohio..... 10- 8
10-14 Storm culvert, Oakland, Cal.... 10- 8
10-14 Sewers, Lawton, Okla..... 10- 8
10-14 Sewer, St. Joseph, Mich..... 10- 8
10-14 Sewers, Philadelphia, Pa..... 10- 8
10-14* Disposal plant, Baltimore, Md.... 9-17
10-15 Sewers, Pipestone, Minn. 10- 1
10-16* Sewer, Louisville, Ky..... 10- 8
10-19 Sewer, Oakland, Md 10- 1
10-21 Sewer, Louisville, Ky 9-24
10-21* Sewer, Louisville, Ky..... 9-24
10-23 Drain, Fort Du Pont, Del. 10- 1
10-24 Sewers, Seattle, Wash 10- 8
10-26 Sewers, Wilkes-Barre, Pa..... 10- 8
10-28* Sewers, etc., Rye, N. Y..... 9-24
11- 2 Sewer pipe, Selma, Cal..... 10- 8

STREETS AND ROADS.

10- 9* Grading, etc., Charleston, W. Va. 10- 1
10- 9 Curb, Dayton, Ohio..... 10- 8
10-10 Excavation, etc., E. St. Louis, Mo. 10- 8
10-10 Grading, etc., Tarentum, Pa..... 10- 8
10-10 Grading, Carthage, Ohio..... 9-17
10-10 Sidewalks, etc., Raleigh, N. C. .. 10- 1
10-12 Roads, Fort Thomas, Ky. 10- 1
10-12 Sidewalks, Wabash, Ind.. 10- 8
10-12 Grading, Jacksonville, Fla..... 10- 8
10-13 Grading, etc., Hagerstown, Md.. 10- 8
10-14 Grading, etc., Cleveland, O. ... 10- 1
10-14 Street impvt., Columbus, Ohio... 10- 8
10-15 Paving, New York, N. Y..... 10- 8
10-15 Curb-stones, New York, N. Y.... 10- 8
10-15 Repaving, etc., New York, N. Y. 10- 1
10-16 Road, Monticello, Ind. 10- 1
10-16 Road, York, Pa..... 10- 8
10-16 Road, Media, Pa..... 10- 8
10-16 Road, Carlisle, Pa..... 10- 8
10-16 Roadway, etc., Salisbury, N. C.. 10- 8
10-17 Road, Terre Haute, Ind. 10- 1
10-19 Macadam, etc., Haworth, N. J.... 10- 1
10-19 Asphalt repair, New York, N. Y. 10- 8
10-19 Sidewalks, Salt Lake City, Utah. 10- 8
10-21 Repaving, etc., Brooklyn, N. Y.. 10- 8
10-21 Grading, Cleveland, Ohio..... 10- 8
10-22 Road impvt., Pittsburg, Pa..... 10- 8
10-22 Roads, Harrisburg, Pa..... 10- 8
10-23 Road impvt., Cincinnati, Ohio... 10- 8
10-24 Road, Portland, Ind..... 10- 1

MISCELLANEOUS.

10- 8 Crematory, Fort Jay, N. Y. (Garbage) 10- 8
10- 9* Wharf, seawall, Mobile, Ala..... 9-10
10-10* Steel stack, boilers, Boston, Mass. 9-17
10-10 Track scale, Ft. George Wright, Wash. 9-24
10-10 Ditch, Elbow Lake, Minn. 10- 1
10-10 Ditch, Redwood Falls, Minn..... 10- 8
10-12 Derricks, railway supplies, Panama 9-17
10-12 Garbage, etc., Reading, Pa..... (Garbage) 10- 8
10-13* Garbage, New York, N. Y. 10- 1
10-14 Levee, Vicksburg, Miss. 10- 1
10-14* Removing wreck, Portland, Me. 9-17
10-14 Steel, Atlanta, Ga..... 10- 8
10-14 Dredging, New York, N. Y..... 10- 8
10-14* Dredging excav., Chicago, Ill..... 9-17
10-15 Levee work, New Orleans, La.... 10- 8
10-15 Cement, New York, N. Y..... 10- 8
10-16 Dredges, Panama 9-24
10-17 Wharf and dredging, Norfolk, Va. 10- 1
10-17 Cranes, Panama 10- 8
10-17 Tile ditch, Hartford City, Ind... 10- 8
10-19 Fire alarm supplies, New York.. 10- 8
10-19* Rock-crushing plant, Washington, D. C. 9-24
10-19 Levee work, Memphis, Tenn..... 9-24
10-20 Snow and ice removal, New York, N. Y. ..... (Garbage) 10- 8
10-20* Gym, apparatus, Ft. Morgan, Ala. 10- 8
10-20 Canal, Ottawa, Ont..... 10- 8
10-21 Rails, ties, etc., Georgia (Rys.).. 10- 1
10-22 Lantern, New London, Conn. 10- 1
10-22 Ry. supplies, tools, Panama..... 10- 8
10-26 Eng supplies, etc., Panama..... 10- 8
10-30 Breakwater and dredging, Rondeau, Ont. 10- 8
10-30 Dredging, Wilmington, Del..... 10- 8
10-30 Coal shed, Fort Hamilton, N. Y.. 10- 8
11- 2 Submarines, Wash., D. C. 8-13
11- 3 Breakwater and dredging, Port Burwell, Ont. 10- 8
11- 9 Battleships, Washington, D. C... 9-17
11-17* Lock and dam, Mobile, Ala..... 9-17
11-18* Coal tower, San Francisco, Cal.. 10- 8
12- 1 Dredging, Hawaii 9-17

FOREIGN.

10-14 Dredging, Spain 7-10
10-14 Tramway, Roumania 9-10
10-14 Ry. telegraph system, Brazil..... 9-17
10-15 Drydock, Italy 9-10
10-21 Power plant, Australia 10- 8
10-21 Railway, Belgium..... 8- 6
10-29 Reservoir, pipe, India 7-16
11- 2 Electric plant, Chile..... 9-10
11- 2 Telegraph material, Australia..... 8- 6
11- 4 Reservoir, India 10- 8
11-26 Mines, Turkey 10- 8
12- 1* Sewers, paving, Ecuador..... 8- 6

CIVIL SERVICE.

10-14 Scient. Asst., Wash., D. C..... 10- 1
10-17 Supt. of Bldgs., Wash., D. C.... 10- 1
10-17 Draftsman, Albany, N. Y..... 10- 1
10-17 Inspector, Albany, N. Y..... 10- 1
10-17 Health Officer, Albany, N. Y.... 10- 1
10-19 Highway Ry. and Irrig. Engr., Philippines 9-24
10-21 Mech. draftsman, Wash., D. C.. 10-24
10-21 Asst. designer, Wash., D. C.... 9-24
10-21 Forest Asst., Philippines..... 9-24
10-28 Lab. aid, Wash., D. C..... 10- 8
10-28 Mech. examiner, Wash., D. C.... 10- 8
11- 6 Clerk, New York 10- 8

RAILWAYS.

ALBERTA NORTHWESTERN.—Incorporated with $500,000 capital to build from Edmonton, Alta., to the British Columbia boundry at Peace River, via Athabasca Landing, Lesser Slave Lake and Dunvegan; also from Edmonton to the International boundry via Medicine Hat. The offices of the company will be at Edmonton. The directors include D. McArthur, Reaburn, Man.; E. F. Getchell, Chicago; F. G. Foster, Medicine Hat, Alta.; N. D. Beck and E. G. Emery, both of Edmonton.

CENTRAL OF GEORGIA.—It is stated that the company is surveying between Cedartown, Ga., and Sprite to shorten the distance between Atlanta and Chattanooga, about 40 miles. C. K. Lawrence is Ch. Engr., Savannah, Ga.

CHERRYVALE, OKLAHOMA & TEXAS.—It is planned by this company to arrange financial matters for the commencement of construction on the road by Dec. 15. Work will begin at Caney, Kan., and extend southward through the Osage Indian Nation, through Guthrie, Okla., and southwest to the Texas state line.

DALLAS & NEW MEXICO.—Contracts probably will be let late in October for the first section of this projected line. The company has acquired coal lands in Jack and Young Counties, Tex. It is expected to have the first 50 miles in operation by April, 1909. The line will extend from Dallas, Tex., northwest to Jacksboro, Seymore, and Lubbock, Tex. Megargel & Co., 5 Nassau St., New York, are interested. Noted on May 7.

GEORGIA.—The Bremen (Ga.) Board of Trade has reviewed the project to build a railroad from Bremen to Bowdon, Ga., 16 miles. A committee composed of J. J. Mangham, J. H. Sheinutt and C. L. Copeland, was appointed, who will at once take the matter up with the management of the Central of Georgia Ry. A similar committee has been appointed by the citizens of Bowdon that will act in conjunction with those of the Bremen Board of Trade.

GEORGIA SOUTHWESTERN & GULF.—We are officially advised that construction contracts will be let probably between Nov. 14 and Dec. 1. This railroad will be 100 miles long, from Albany, Ga., southwest to St. Andrews Bay, Fla., on the Gulf of Mexico, via Colquitt and Donaldsonville, Ga., and Marianna, Fla. Right-of-way is secured, surveys completed and specifications are being prepared. Capital has been obtained. W. M. Legg is Pres., 534 Washington Ave., Macon, Ga.; T. H. Hazelrigg is Ch. Engr., 126 East Market St., Indianapolis, Ind. Noted on Aug. 13.

GRAND TRUNK PACIFIC.—Collingwood Schrieber, Gen. Consult. Engr. for the Dominion Government, Ottawa, has announced that the company will call for bids soon for the construction of sections eastward from Prince Rupert and westward from the Yellowhead Pass, leaving approximately 400 miles of the entire length of the main line from coast to coast to be put under contract. B. B. Kelliher, Montreal, Que., is Ch. Engr.

GULF, COLORADO & SANTA FE.—In the issue of Sept. 24 it was incorrectly stated that "it is announced that this company within 30 days will begin the construction of a line from Cleburne to Glen Rose, Tex., a distance of 100 miles."

HOBART MOTOR R. R.—Incorporated in Oklahoma, with $100,000 capital, to build a number of lines radiating from Hobart, Okla., as follows: One through Kiowa, Washita and Beckham Counties, about 80 miles; one through Kiowa, Washita, Caddo and Canadian Counties to Oklahoma City, about 125 miles; and one through Kiowa and Jackson Counties to Altus, about 55 miles. The estimated cost of construction and equipment is $15,000 a mile. The incorporators are: H. H. Hoover, R. E. Nye, Arthur Johnston, A. B. Wey, J. H. Montgomery and J. Elanor, all of Hobart, Okla.

MEMPHIS, PARIS & GULF.—Bids will be received by C. W. Dodson, Nashville, Ark., general contractor, for sub-contracts to cover 15 miles of grading between Nashville, Ark., and Murfreesboro, Ark. C. C. Henderson, Nashville, is Vice-Pres. and Gen. Mgr. Noted on Aug. 27.

MOBILE, JACKSON & KANSAS CITY.—This company will extend its line from Jackson, Tenn., to Evansville, Ind., and from Houston, Tenn., to Birmingham, Ala., soon. W. F. Owen, Gen. Mgr., Mobile, H. W. Bell, Res. Engr., Laurel, Miss.

NEW ORLEANS, MOBILE & CHICAGO.—This company has notified the Secretary of State of Alabama of its incorporation from the consolidation of the following three lines: Mobile, Jackson & Kansas City, Gulf & Chicago and the New Orleans, Mobile & Chicago. The capital stock is $16,500,000, of which $5,000,000 is preferred and the balance common. Old stock of any of the lines is exchangeable for the new at par. The general headquarters will be in Mobile, Ala.; with Mississippi offices at Lauren, and Tennessee offices at Middleton. The officers of the new company are as follows: L. S. Berg, Pres., and Brayton Ives, Vice-Pres., New York; G. W. Crary, Secy.-Treas., Mobile; Gen. Manager, W. F. Owen, Mobile. The directors are Messrs. Berg and Brayton and the following, all of New York: W. D. Stratton, A. McDonald, J. W. Simpson, H. C. Snyder, W. B. Rogers, G. R. Sheldon, A. P. Walker, M. C. Humstone and M. C. Bogue. This road runs through much of the best timber section of the states of Alabama and Mississippi and some of farming territory of the same state, as well as that of Tennessee. The new organization makes it possible for the company to do a great deal of enlargement work that cannot now be reached. Noted on Sept. 17.

NORTHERN PACIFIC.—The State Board of Land Commissioners of Montana has granted the Northern Pacific right-of-way for a line from Glendive to Mondak, in eastern Montana. The company will build a line north of Mandan, N. Dak., following the Missouri River to its confluence with the Yellowstone River at Mondak, thence proceeding southerly through the lower Yellowstone reclamation project. In North Dakota the line will traverse a section of territory without railroad facilities. The project will involve about 300 miles of railroad building. W. L. Darling, St. Paul, Minn., is Ch. Engr.

TENNESSEE.—See Chattanooga item under Buildings.

TRANS-CONTINENTAL.—Contracts aggregating 350 miles have been let for the construction of the two remaining sections west of Lake Abitibi, bids for which were received on Sept. 28. O'BRIEN & MACDOUGALL, of Ottawa, were the successful bidders in each case. Noted on Sept. 24 and Oct. 1.

VANCOUVER, VICTORIA & EASTERN (Great Northern).—Sub-contracts for work on the extension of this line in the vicinity of Princeton, B. C., are reported to have been let to ERICKSON & CO., WILLIAMS & CO., JOHNSON & CO., H. B. RICHARDSON, ANDERSON & CO., FREEDEN & CO. and the LARSON CO. These contracts are mostly all rock work. A. Hogeland, St. Paul, Minn., is Ch. Engr., G. N. Ry.

WASIOTO & BLACK MOUNTAIN.—The company will build a line from a connection with the Louisville & Nashville, near Wasioto, Ky., up the Cumberland River, ten miles. A. B. Gloster, Middlesboro, Ky., is Engr.-in-Charge.

ELECTRIC RAILWAYS.

ROCHESTER, N. Y.—The Public Service Commission has authorized the Rochester, Corning & Elmira Traction Co., Rochester, to issue $1,000,000 of bonds. The company proposes to build and operate an electric railway between Rochester, Corning and Elmira, that will permit the operation of high-speed express trains, besides slower local trains. The road is to be built in sections, beginning at the south line of Rochester. The first section will include the distance between Rochester and Lakeville, on Conesus Lake, and other sections will be begun as soon as the first is under way. L. Feuerstein, 27 Church St., Rochester, is Engr.

TITUSVILLE, PA.—It is announced that the Titusville Electric Traction Co. will commence construction about Nov. 1 of its proposed extension which is to connect Titusville with Union City by way of Riceville and Lincolnville. The grading will start on the Union City end of the line. The preliminaries have been completed and the right-of-way has also been secured between Clappville and Cambridge Springs. W. J. Smith is Pres. and Gen. Mgr., Titusville.

CHAMBERSBURG, PA.—The officials of the Chambersburg & Western Electric Ry. Co. have decided to start work at once obtaining right-of-way for its proposed line to St. Thomas, Pa. R. W. Ramsey is Pres.

MANSFIELD, PA.—W. A. Seits, of Jersey Shore, Pa., has applied for a franchise to build a street railway system on the streets of Wellsboro and to extend to Mansfield. The company will be known as the Tioga Traction Co. and will enter Mansfield by way of Wellsboro St., with a terminal at the corner of Main St. A 50-year franchise is desired, with permission to construct a switch at the intersection of Wellsboro St. and Morris Ave.

ALEXANDRIA, VA.—The Washington, Alexandria & Mt. Vernon Ry. Co., Washington, D. C., and the Washington Southern Ry. Co., are planning to make improvements

on King St., Alexandria, it is stated. The work will cost $18,000. R. W. King, Washington, is Gen. Mgr.

CHARLOTTE, N. C.—The Charlotte Power Co. which has been granted a franchise through Gastonia for its proposed electric railway, has been granted franchises in Mount Holly and Lowell also for its road, which will run from Charlotte to various towns. W. S. Lee and others are interested.

MIAMI, FLA.—The Miami Electric Ry. Co. will build an extension to the cemetery and in the winter probably will extend to Lemon City. Albert Ogle is Supt., Miami.

NEW ORLEANS, LA.—The Grand Isle Development & Construction Co., New Orleans, has been chartered to construct an electric railroad from New Orleans to Grand Isle, as projected by the New Orleans & Seashore Air Line Ry. Co. Capital stock, $300,000. L. H. Marrero, Sr., Amesville, La.; L. H. Marrero, Jr., Hennen Bldg.; J. W. T. Stephens, Seeley Dunn, Cora Bldg.; and Charles Farwell, are Dirs.

SHERIDAN, IND.—The Sheridan, Westfield & Indianapolis Traction Co. is planning to let a contract soon for the construction of a traction line from this city to Carmel.

GALESBURG, ILL.—Incorporation papers have been granted to the Galesburg, Aledo & Northwestern R. R. Co. to build an electric railway from Galesburg in a west and north direction, through the counties of Knox, Warren and Mercer, to Aledo, and from there through the county of Rock Island to Rock Island, Ill., and Muscatine, Iowa. Capital stock, $10,000. Incorporators: Lafayette Weinberg, G. B. Churchill, F. W. Latimer, B. F. Arnold, E. R. Drake, Charles L. Hibbard, C. F. Hurburgh, Lake W. Sanborn, Thomas W. Peterson.

TAYLORVILLE, ILL.—The work of constructing an electric railway between Taylorville and Nokomis, Ill., will be started at once, it is reported. The road will be 21 miles in length and the route will be the old Nokomis-Taylorville wagon road through Johnson, Bear Creek and Greenwood Townships, in Christian County. The company will be capitalized at $1,000,000. The right-of-way has been secured along the entire route, including the street franchises in Taylorville and Nokomis. Noted on July 2.

MANHATTAN, KAN.—A franchise has been granted by the City Council to W. R. West and Joseph T. West, of Kansas City, for an electric railway system to be built in Manhattan. Construction is to begin within 30 days, and the line to the Agricultural College, a distance of two miles, is to be completed within six months.

WINFIELD, KAN.—The Southwestern Interurban Ry. Co. will award contract within six months for the construction of an interurban line in Arkansas City, Kan., and Winfield, with track for local lines in both cities. The work of electrifying the present line in Winfield has already begun.

BILLINGS, MONT.—Surveys are being made for the route of the Billings & Cooke City Ry. Co., which is to be built from Cooke City via Nye, Dean, Joliet, Laurel and Billings. Cooke City is located within six miles of the northwest corner of Yellowstone Park. The company is planning to begin work on the road at once. Power for the operation of the lines will be furnished by the Stillwater Power Co. from a station which is to be built at Stillwater Canyon. Capital stock, $2,000,000, of which $100,000 has been issued. J. B. Clayburg, Helena, Mont., is Pres.; A. L. Babcock, Billings, Vice-Pres. and Treas.; George H. Savage, Billings, Secy. and Gen. Mgr.

TEMPLE, TEX.—We are officially advised that W. D. Boyce and Wm. Ginnuth, Mayor of Temple, and associates, have surveyors in the field locating an electric railway to connect Temple, Waco, Marlin and Salado, Tex., 54 miles. A capital of $200,000 has been subscribed. As soon as surveys are made and right-of-way is secured contracts will be let.

SPOKANE, WASH.—The Spokane Traction Co., according to the Spokane "Spokesman-Review," has applied to the Council for a blanket franchise extending its lines in the east and southeastern parts of the city, with the right to build Y tracks running north and south in such manner as to connect the east and west lines in that part of the city. The franchise application proposes to establish connections, the chief of the proposed extensions being to connect with that branch of the system coming into the city via the Olive Ave. route. The franchise applied for is as follows: Connecting with the company's proposed line on East Sprague Ave. at Sprague Ave. and Freya St., running east to the east city limits. Connecting with the company's line at Fifth Ave. and Regal St., extending east on Fifth Ave. to Freya St., with the right to place a Y track on Freya St. Freya St. is eight blocks east of Regal St., the old city limits, and is seven blocks west of the present city limits. A line connecting with the present line at Southeast Boulevard and Hatch St., extending southeast on the boulevard to 16th Ave., east on 16th Ave., to Pittsburg St., south on Pittsburg St. to 17th Ave., east on 17th Ave. to Crestline St., north on Crestline St. to Ray St., with the right to place a Y track on Ray St. The street is four blocks east of the old city limits at Regal St. Another line connecting with the company's Manito Park system at Ninth Ave. and Grand St., east one block to North St., which faces the city reservoir on the south, southeast on North St. three blocks to City View St., south on City View St. one block to Rosedale Boulevard, southeast four blocks to Hatch St., with the right to lay Y tracks on Hatch St. Rosedale Boulevard and Hatch St. join at 14th Ave.

The franchise application announces that the tracks on Rosedale Boulevard and Southeast Boulevard are to be built in lieu of tracks on Rose Ave., Rose Court and Prospect St.; and for this reason the company will be willing for the revocation of its franchise on Rose Ave., across private property, across City View St. to Rose Court and along Rose Court to its western limit, and across private property to Prospect St., then southwest to the western terminus. The Spokane Traction Co. is controlled by the Spokane Inland Empire R. R. Co., A. M. Lupfer, Spokane, Ch. Engr.

SAN FRANCSCO, CAL.—The Board of Supervisors has granted permits to the United Railroads of San Francisco, Oak and Broderick Sts., to lay track temporarily at Market and Second Sts., and at Market and Twelfth Sts. A permit was granted the company to lay tracks from a point on Pacific Ave., between Polk and Van Ness Sts., to the company's car house. Charles N. Black is Vice-Pres. and Gen. Mgr.; E. D. Hibbs is Gen. Supt.

TORONTO, ONT.—The Toronto & York Radial Ry. Co. is planning to extend its line from Yonge St. to Markham village and on to Locust Hill, eventually reaching Port Perry. W. H. Moore, Gen. Mgr.

LIGHT AND POWER PLANTS.

(denotes that this work is advertised in Engineering News.)*

FARMINGTON, N. H.—Plans are being prepared by W. D. Allen for making an addition to his electric light and power plant, which include the installation of a Curtis turbo-generator set to replace the Fitchburg engine now in use. The new equipment will give the plant an output of 225 HP.

BATH, N. Y.—The Economic Power & Construction Co., of Buffalo, has made surveys at Bath, N. Y., for the purpose of installing a central steam heating plant in connection with the electric lighting plant which the Citizens Electric Service Co. of this village is to build. J. Bendure is Consult. Engr., Economic Power & Construction Co., 346 Ellicott Sq. Bldg., Buffalo.

NEW YORK, N. Y.—Bids are asked until 3 p. m., Oct. 15, by the Park Board, Henry Smith, Pres., for furnishing and installing Electric lighting fixtures in the new addition (E) of the Metropolitan Museum of Art, located in Central Park, on the west side of Fifth Ave., opposite 83d St., Boro. of Manhattan.

Bids are asked until 10 a. m., Oct. 19, by Theodore Bingham, Police Comr., for furnishing and erecting all the materials necessary to install the light and electric fixtures in the new building to be erected on the block bounded by Grand, Centre and Broome Sts., and Centre Market Pl., Boro. of Manhattan, for headquarters for the Police Department of the City of New York.

PHILADELPHIA, PA.—A permit for the erection of a power-house on the south side of Oregon Ave., west of 20th St., has been granted to HERBERT E. HAVENS, Girard Bldg., contractor. It will be constructed from plans by James H. Windrim, of reinforced concrete, will measure 88 × 32 ft., and will cost $20,000. It is to be built for the Girard Estate, and will supply light and heat to a number of houses being erected in the vicinity.

LAUREL, DEL.—WALLACE STEBBINS & SONS, Charles and Lombard Sts., Baltimore, Md., have been awarded the contract for equipment for the municipal electric light plant, for $11,766. The contract for enlarging and repairing the power-house was awarded to C. W. DONALDSON, of Laurel, Del.

FRIENDSVILLE, MD.—The Western Maryland Coal & Coke Co. will develop water-power of the Youghiogheny River and build an electric plant to generate and transmit 15,000 HP. for coal mining, lighting and other purposes. John L. Bogart, 115 Broadway, New York, has examined the power and estimated that three dams 30, 75 and 100 ft. high, will accumulate enough water for turbines to develop the 15,000 HP. Estimated cost of plant, $1,000,000. C. L. Pullen, New York, N. Y., is Vice-Pres.

WASHINGTON, D. C.—Bids are asked until noon, Oct. 14, by Elliott Woods, Supt. of U. S. Capitol Buildings and Grounds, Washington, for furnishing about 25,000 electric lamps for the U. S. Capitol Building.

Bids were received on Sept. 30 by Elliott Woods, Supt. of the U. S. Capitol Building and Grounds, for furnishing and erecting fans, electric motors and steam heaters required for the ventilation of the U. S. Senate Office Building, as follows: McCay Engineering Co., 9 East Lexington St., Baltimore, Md., item 1, in accordance with specifications, $19,945; item 2, using 1-in. heater coils and 10-in. pipe, $19,445; time, commence in five weeks and complete erection within 30 days thereafter. B. F. Sturtevant Co., Washington, D. C., $13,985.50; time as per specifications. Diehl Mfg. Co., Elizabethport, N. J., $17,980; time as per specifications. National Electrical Supply Co., Washington, D. C., $17,705; time as per specifications. New York Blower Co., 25th Pl. and Stewart Ave., Chicago, Ill., $16,736; time as per specifications. The Green Fuel Economizer Co., Mattewan, N. Y., $19,975; time as per specifications.

WASHINGTON, D. C.—Bids were received as follows Oct. 3, at the Bureau of Yards and Docks, Navy Dept., Washington, for furnishing four 1,000-KW. and two 500-KW. turbo-alternators at the Navy Yards, New York, Philadelphia, Norfolk, Mare Island and Puget Sound: General Electric Co., Schenectady, N. Y., $119,90); Westinghouse Machine Co., 165 Broadway, New York, N. Y., $89,995; Allis-Chalmers Co., Milwaukee, Wis., $119,310.

RICHMOND, VA.—The plans and specifications prepared by E. W. Trafford, Consult. Engr., for the water pumping portion of the proposed municipal electric light plant have been approved by Charles E. Bolling, City Engr., it is stated. The plans call for four electric units, each with a capacity of pumping 4,000,000 gallons of water a day. The committee recommends that the plans be adopted by the City Council and that bids be called at once for the erection of pumps, the cost of which is estimated at $17,000. It is proposed ultimately to use the present pumping-station for a power-house and to erect transmission lines to the new pumping-station to furnish electricity to operate the pumps, and also to install a system for lighting the streets of the city. In July the Board of Aldermen passed an ordinance appropriating $350,000 for the project.

LYONS, GA.—W. J. EDWARDS & CO., Fourth National Bank Bldg., Atlanta, Ga., have contract to construct the proposed electric light plant and water-works at Lyons; work to begin within 30 days.

MERIDIAN, MISS.—William F. Wilcox, Gen. Mgr. of the Meridian Water-Works, will prepare plans for street-lighting plant, to be built duplicate and to cost approximately $60,000.

CLEVELAND, OHIO.—An option has been secured on a lot 265 × 122 ft. at the foot of West Eleventh St., for the site of the proposed plant of the county court-house. Gen. Jared A. Smith, Citizens Bldg., Cleveland, is Pres. Bldg. Comn.

NEWTON FALLS, OHIO.—Plans have been prepared by Roberts & Abbott, Engrs., Schofield Bldg., Cleveland, Ohio, for two power-houses to be built at Newton Falls for the Peerless Electric Co., of Warren.

XENIA, OHIO.—Contracts for furnishing material and construction of new power plant and remodelling the present lighting and water system for the Ohio Soldiers' and Sailors' Orphans' Home has been awarded by the Board of Trustees as follows: For construction of buildings, tunnels and stacks, to A. B. LEISTER, of Dayton, Ohio, for $25,567, and for equipment, to HUFFMAN & CONKLIN, 661 North High St., Columbus, Ohio, for $35,845.

YPSILANTI, MICH.—The City Council has granted a 30-year franchise to the Washtenaw Light & Power Co., and it is stated that about $60,000 will be expended for a power and light plant and for improvement of the Huron River. Construction work will be begun this fall or early in the spring.

JOLIET, ILL.—We are officially advised that the Joliet National Bank will construct a 6-story and basement power plant, 67 × 157 ft., here. It will be of fireproof steel construction, and will be equipped with two 85-HP. engines, two 50-KW. generators and two 60-in. × 16-ft. boilers. Plans have been completed by Julien Barnes, 153 La Salle St., Chicago, Ill., Arch.

HARTLEY, IOWA.—We are officially advised that the town of Hartley has awarded contract to the MINNEAPOLIS STEEL & MACHINERY CO., 29th and Minnehaha Sts., Minneapolis, for an 80-HP. Muenzel producer gas engine and suction gas producer for the municipal electric light plant. Bids were received on Sept. 24.

LANDER, WYO.—R. C. Adams, Bond Bldg., Washington, D. C.; W. E. Rowsey, of Muskogee, Okla., and Leo Adams, of Washington, have purchased 220 acres of oil land in the Dallas Field, near Lander, and will build a plant for the generation of electrical power. Their plan is to sink a number of wells and use crude oil as fuel for generating steam and electricity. They expect to distribute power throughout the entire region, centering at Dallas, including the South Pass district to the south and the Copper Mountain district to the north.

GARDEN CITY, MO.—Plans are being prepared for the proposed power plant to be constructed by the Kansas-Colorado Electrical Transmission Co., in Garden City. The plans call for a building 130 × 160 ft., in which will be placed three units of 3,750 KW. each.

NORTH YAKIMA, WASH.—Plans are being made by the Northwest Light & Water Company to extend its system between Yakima and Kennewick, to furnish electricity for lamps and motors, the cost of which is estimated at $250,000. The company has a hydro-electric plant at North Yakima and is planning to develop another water-power at Kennewick. George Arrowsmith is Supt.

SAN DIEGO, CAL.—Work will begin in the winter on the proposed electrical plant to be installed by the Benson Lumber Co., foot of 23d St. O. J. Evenson is Mgr.

SOLDIERS' HOME, CAL.—Bids will be received at office of E. W. Moore, Treas., Pacific Branch, N. H. D. V. S., Soldiers' Home, Los Angeles County, Cal., until noon, Oct. 16, for furnishing electric motor for laundry, for installing dynamo in power-house and for removal of steam header and main, hot water and return pipes, in power-house.

LOS ANGELES, CAL.—Bids are asked until Oct. 12 by the Board of Public Works for furnishing electrical machinery and apparatus, consisting of electric locomotives, motor generators, motors, poles, cross-arms, insulators, and U bolts. This material is for use on the Los Angeles aqueduct.

OAKLAND, CAL.—The Great Western Power Co. has started upon the preliminary work to the erection of a $2,000,000 auxiliary steam power plant on the company's tract of land on Sessions Basin, near the foot of Seventh Ave., Oakland. H. P. Wilson is Vice-Pres., Crocker Bldg., San Francisco, Cal., and 115 Broadway, New York, N. Y.

SAULT ST. MARIE, ONT.—The Lake Superior Power Co. has awarded to ALGOMA POWER CO. a contract to install a hydro-electric plant on the Michipicoton River. The power unit will consist of a 1,000-HP. single horizontal turbine water wheel direct connected to a 600-KW. alternating-current generator. For the exciter unit, there will be a 60-KW. direct current generator, direct connected to a 110-HP. turbine. Transformers will reduce the current from 10,000 volts to 600 volts. The contract for this has been awarded to ALLIS-CHALMERS-BULLOCK, LTD., Sovereign Bank Bldg., Montreal, Que. A large portion of the power will be used to operate the present mining plant which will be changed from steam to electric drive by motors. The contract for the electrical equipment has also been awarded to Allis-Chalmers-Bullock, Ltd.

LETHBRIDGE, ALTA.—We are officially advised that Smith, Kerry & Chace, Engrs., Confederation Life Bldg., Toronto, Ont., are preparing plans for a water [illegible] and lighting plant for this [illegible] supply system

VICTORIA, B. C.—It is [illegible] that W. Meredith, Electrical Engr., [illegible] British Columbia Electric [illegible] will report favorably on Jor[illegible] a source for the supply of [illegible] addition the company is look[illegible] of supply in the vicinity of [illegible] Sperling, Vancouver, B. C., [illegible] Meadows as power. In [illegible] source [illegible] R. H. [illegible], Mgr.

NELSON, B. C.—We are [illegible] that Cecil B. Smith, Electri[illegible] federation Life Bldg., Toro[illegible] been requested to prepare pla[illegible] a second unit at the civic [illegible] Bonnington Falls. C. H. Bo[illegible] at once for station at City Clerk.

BRIDGES.

(denotes that this work [illegible] Engineering News.)*

BRIDGEPORT, CONN.—R. [illegible] Stoddard, Consulting Engr., Milford, [illegible] has prepared plans for the construc[illegible] a bridge over the Pequonnock River, [illegible] Bridgeport, bridge to be of [illegible] with reinforced-concrete abutments, [illegible] four spans and approaches. Estimated [illegible] $250,000. Bids will soon be asked by th[illegible] mission. M. W. Manwaring is [illegible] Bridge Commission.

ALBANY, N. Y.—Nine bids [illegible] received by F. C. Stevens, Supt. of [illegible] Wks., on Oct. 1, for Barge Canal Con[illegible] No. 18, which is for furnishing and er[illegible] in place steel highway bridge superstructures as follows: On Contract No. 12, Erie Canal, Section 6: Bridge at Station 2900+83; bridge at Station 2960+00; bridge at station 3185+48. On Contract No. 18, Erie Canal, Section 4: Bridge at Station 3894+31; bridge at Station 3951+12. Engineer's estimate, $29,775. The bids were: The Kane Bridge Co., Painted Post, N. Y., $28,[illegible]; United Construction Co., 467 Broadway, Albany, N. Y., $27,052; Michael Fitzgerald, Hoosick Falls, N. Y., $28,039; Penn Bridge Co., Beaver Falls, Pa., $23,676; L. P. Shoemaker & Co., Harrison Bldg., Philadelphia, Pa., $29,145; J. B. & J. M. Cornell Co., 30th St. and Eleventh Ave., New York, $26,296; Groton Bridge Co., Groton, N. Y., $26,478; McClintic-Marshall Construction Co., Pottstown, Pa., $24,163; Montour Steel Co., Montour Falls, N. Y., $26,272. Frederick Skene is State Engr. and Surv. Itemized prices will be given next week.

PHILADELPHIA, PA.—Bids are asked until noon, Oct. 14, by the Department of Public Works for the construction of a bridge on the line of Fox St. over the Richmond branch of the Philadelphia & Reading Ry., 38th Ward. Plans and specifications are on file at the office of Engineering News, New York. George R. Stearns is Dir. Pub. Wks.

MONONGAHELA, PA.—The Allegheny-Washington County bridge over the Monongahela River here is being delayed until the Commissioners of Washington County can sell the bonds to cover their share of the cost. No contracts will be awarded until the bond question is settled. List of itemized bids is given in this issue under "Contract Prices."

NORRISTOWN, PA.—The LOGAN CONSTRUCTION CO., and LEWIS SHOEMAKER, Harrison Bldg., Philadelphia, Pa., were awarded the contract on Sept. 29 by the County Commissioners for the construction of the sub and superstructure for the bridge over Stony Creek at Markley St., at about $14,000.

WEST CHESTER, PA.—The Commissioners of Chester County on Sept. 28 awarded the contract for the erection of a county bridge at Waterloo Mills, Easttown Township, to the LOGAN CONSTRUCTION CO., of New York, at $3,400. William Stevens is Chn. Comrs.

WASHINGTON, D. C.—We are officially advised that bids were received as follows on Oct. 3 by the Bureau of Yards and Docks for a single-leaf, railway, rolling-lift bridge at the Navy Yard, Washington, specifications No. 1597: Interstate Engineering Co., Bedford, Ohio, $30,986; Penn Bridge Co., Bond Bldg., Washington, $16,989, $16,390, $18,400, $17,840, $18,750; Minneapolis Steel & Machinery Co., Minneapolis, Minn., $26,410; Stroebel Steel Construction Co., 98 Jackson St., Chicago, Ill., $14,650, $14,200; Augustus Smith, 149 Broadway, New York, $19,102, $19,222, $19,150; Cowing Engineering Co., Collingwood, Ohio, $14,875.

CECIL, W. VA.—The contract for the stone work for the new bridge across Tygart's Valley River at Cecil, has been awarded by the County Court to JOSEPH FUCIE, of Weston, at $7.85 per cu. yd.

DURHAM, N. C.—The Durham County Commissioners will erect a 90-ft. wooden bridge at Christian's Mill to replace the structure destroyed by the recent flood.

LILLINGTON, N. C.—The Harnett County Commissioners, C. K. Grantham, Chn., Dunn, N. C., have awarded the contract to the CAROLINA ENGINEERING CO., Burlington, N. C., at $30,000 for the construction of two steel bridges across Cape Fear River, one at Lillington and the other at Duke, N. C. Four piers in river will require about 1,100 cu. yds. of gravel concrete and bids for piers are asked.

GREENSBORO, N. C.—The Guilford County Commissioners have awarded the contract to W. J. GRANTHAM of Greensboro for constructing abutments for the steel bridge across the river near High Point, N. C., and to OWEGO BRIDGE CO., Owego, N. Y., for chute piers for McCuiston bridge across Reedy fork.

MERIDIAN, MISS.—We are officially advised that the MISSOURI VALLEY BRIDGE & IRON CO. has been awarded the contract by the city for the construction of a concrete bridge on Eighth St. at $4,747. W. G. Wetmore is City Engr.

TAYLORSVILLE, OHIO.—Bids are asked until Oct. 19, by the County Commissioners for constructing a bridge at Taylorsville.

BYESVILLE, OHIO.—Bids are asked until 11 a. m., Oct. 26 by the Commissioners of Guernsey County for furnishing material

and erecting two stone abutments with wing walls for a bridge to span Wills Creek at the foot of Tenth St., Byesville, Jackson Township.

PORTSMOUTH, OHIO.—Bids are asked until [illegible] Oct. 27, by Fred N. Tynes, County Audr., for all the labor and material necessary to construct, contract and complete an arch bridge, of stone or concrete, at Pond Creek, Rush Township.

FREMONT, IND.—Bids are asked by the Commissioners of Clinton County until Nov. 7, for the furnishing of all materials and constructing bridges as follows: Bridge over Sugar Creek near Michigantown; over Kilmore Creek near Forest; bridge over Worden Creek near Forest; bridge over Middlefork Creek at Middlefork, bridge over Swamp Creek known as the [illegible] bridge. C. F. Cromwell is County Auditor.

INDIANAPOLIS, IND.—Bids are asked by the Commissioners of Marion County until 10 a. m., Oct. 22, for the construction of the following bridges and culverts: Bridge over creek on Bunker Hill road; bridge over creek on Main st, Beech Grove; bridge over creek on Bluff Road; culvert on Pleasant Run on Bluff Road; culvert on road south line Decatur Township; culvert on road, Morris St.; culvert on Fall Creek and road, Lawrence Township; culvert on Mud Creek Road, Lawrence Township; culvert, road in Decatur Township, and culvert on road in Decatur Township. Albert Sahm is County Audr.

SALEM, IND.—Bids are asked by the County Commissioners, Grant County, until 2 p. m., Oct. 15, for the construction of six concrete arches, and for the re-roofing of the wooden bridge across the Mississinewa River in East Matthews, Grant County. A. Y. Stout is County Audr.

WOODLAND, ILL.—W. H. SHONS, of Freeport, Ill., was awarded the contract on Sept. 24 by the county for the construction of the Pauley bridge here, 100-ft. span, at $2,329.

STERLING, ILL.—The CLINTON BRIDGE & IRON WORKS secured the contract on Sept. 26 for the construction of seven bridges in Hume Township at $6,000.

ST. PAUL, MINN.—The St. Paul Union Stock Yards Co. are having plans prepared for a steel arch bridge to span the Mississippi River from South St. Paul to a point midway between St. Paul and South Park. William Magivny is Pres. Estimated cost, $350,000.

SIOUX FALLS, S. DAK.—Bids are asked until Oct. 15 by W. A. Cornell, County Audr., for constructing a steel bridge over Big Sioux River at Eighth St., two 130-ft. spans with a 26-ft. roadway and two 6-ft. walks, the city to furnish piers and abutments.

MISSOULA, MONT.—The County Commissioners on Sept. 23 awarded the contract for the new Higgins Ave. bridge, to be constructed across the Missoula River here, to the OLIVER BRIDGE CO., 1411 West Mallon Ave., Spokane, Wash. The company submitted seven different plans for the structure ranging from $121,780 to $160,000. The bid for the plan selected is $128,450. The bridge consists of one 132-ft. span, six 110-ft. spans, and 130 ft. of steel bent approach, clear roadway 32 ft. and two 10-ft. walks; roadway and sidewalks to be of reinforced concrete and remainder of superstructure to be of steel. The substructure will be concrete on pile foundation. O. H. Strattan, Spokane, is Design Engr.

KANSAS CITY, MO.—Bids are asked until 11 a. m., Oct. 13, by Oscar Koehler, County Superv., Court House, for constructing 3 × 3-ft. concrete box culvert, and an 8-ft. stone culvert with reinforced-concrete cover.

KANSAS CITY, MO.—The Union Pacific Ry. Co. plans to build high bridge across the Kaw River, the structure to be 734 ft. long, 30 ft. above low water, piers sunk to bedrock. Russell L. Huntley is Ch. Engr., Omaha, Neb.

MUSKOGEE, OKLA.—Bids are asked until 10 a. m., Oct. 15, by W. E. Looper, County Clk., for the construction of 19 bridges in different parts of Muskogee County.

SULPHUR, OKLA.—H. V. Hinckley, Consulting Engr., Sulphur, has prepared plans for the construction of a steel-concrete arch bridge across Rock Creek in Platt National Park. Estimated cost, $25,000.

EVERETT, WASH.—Bids will be received by the County Commissioners until Oct. 12 for the construction of a 300-ft. wooden bridge over a gulch near the old Bright farm.

LOS ANGELES, CAL.—Bids are asked until 2 p. m., Oct. 12, by C. G. Keyes, County Clk., for constructing pile trestle bridge on the Country Club drive.

BARSDALE, CAL.—Plans are nearing completion for the construction of the bridge across the Santa Clara River at Barsdale. The main structure will be 1,100 ft. long, the north approach 500 ft. and the south approach 1,000 ft.

SAN BERNARDINO, CAL.—Plans are being prepared by M. L. Cook, County Surv., for the construction of a steel bridge over City Creek on Highland Ave.

BUILDINGS.

(denotes that this work is advertised in Engineering News.)*

LANCASTER, MASS.—Plans are being prepared by Winslow & Bigelow, Archs., Phillips Bldg., Boston, Mass., for a country house to be erected in Lancaster for Eugene van Rensselaer Thayer, to cost about $30,000. Besides the house there will be built a stable and a garage.

HARTFORD, CONN.—Bids are asked until 12 a. m., Oct. 12, by the Board of Contract and Supply, City Hall, for construction of a fire-house on Fairfield Ave. James P. Berry is Secy. Bd.; Zunner & Bellew, 756 Main St., Hartford, are Archs.

NEW YORK, N. Y.—Bids are asked until 2.30, Oct. 14, by Robert W. Hebberd, Comr. Dept. Public Charities, for erection and entire completion (excepting steam heating and electric lighting) of an enclosed veranda at the east end of the Pavilion for Male Blind, New York City Home for the Aged and Infirm, Blackwell's Island; also for the erection and entire completion of two fire escapes on School for Feeble-Minded Children, and iron balconies on the North Hospital, Ward 15, and old Pavilion A, B, C, at the New York City Children's Hospitals and Schools, Randall's Island.

Plans have been filed with the Building Superintendent for a 12-story hotel to cost $450,000. The hotel is to be built in 56th St., west of Sixth Ave., near Carnegie Hall, for George E. and M. E. Coleman, from plans furnished by Schwartz & Gross, 35 West 21st St., and B. N. Marcus, 35 West 21st St., Archs. It will have a frontage of 175 ft. in 56th St. and a depth of 89 ft., with an "L" of 20 ft. frontage facing on 57th St. The building is to be of the Renaissance type, with facades of brick, finished with limestone and terra cotta, having large bays and peaked towers.

Plans have been filed for the 10-story office, studio and store building to be built by the Brunswick Realty Co., of which Robert P. Zobel is Pres., at 121 and 125 East 27th St., running through to 118 East 28th St. The structure will cost $300,000. F. C. Zobel, 114 East 28th St., is Arch.

NEW YORK, N. Y.—We are officially advised that the NATIONAL FIRE PROOFING CO., 115 Adams St., Chicago, Ill., has secured the contract for furnishing the terra cotta hollow tile fireproofing for the 17-story building to be put up on the site of the old Everett House, Union Sq.

Plans for 19 3-story brick dwellings to be erected in the Bronx by John Massimino have been filed by William L. Rouse, Arch., 11 East 43d St. Twelve of the houses will be at the corner of Davidson Ave. and 177th St., two at the southwest corner, two at the northeast corner of Tremont Ave. and 177th St., and three on Davidson Ave., 90 ft. north of 177th St. The total estimated cost is $190,000.

A 5-story and attic dwelling house is to be built for W. W. and T. M. Hall on the lot 12 West 51st St., a Columbia University leasehold. It is to be 22 ft. front and 66 ft. deep, with an extension. It will be of brick, with limestone trimmings, of the Italian Renaissance design, with an entrance finished with an Ionic porch. It will cost $50,000. Alexander McMillan Welch, 11 East 42d St., is Arch.

NEW YORK, N. Y.—Bids are asked until 11 a. m., Oct. 20, by John V. Coggey, Comr. Dept. of Correction, for erection and entire completion of the improvements to the city prison, Boro. of Brooklyn, situate at the corner of Raymond and Willoughby Sts., Boro. of Brooklyn.

Bids are asked by the Park Board until 3 p. m., Oct. 15, for the furnishing and erecting of an electric passenger elevator in the new addition (E) of the Metropolitan Museum of Art, located in Central Park, on the west side of Fifth Ave., opposite 83d St., Boro. of Manhattan.

We are officially advised that the TURNER CONSTRUCTION CO., 11 Broadway, has been awarded the contract by the New York Central & Hudson River R. R. Co., G. W. Kittredge, Ch. Engr., for the construction of the driveway floor between the post-office and the northeast wing of the Grand Central Station at Depew Pl., New York. Work will be started at once.

NEW YORK, N. Y.—Bids are asked until 2 p. m., Oct. 16, by the Armory Board, for furnishing all the labor and materials required in installing alterations, improvements, etc., in the 69th Regiment Armory, Boro. of Manhattan.

*POUGHKEEPSIE, N. Y.—The following bids were received on Sept. 29 by the State Lunacy Commission for the work of furnishing and installing four horizontal tubular boilers at the Hudson River State Hospital at Poughkeepsie, N. Y.: J. J. Horan & Co., Troy, N. Y., $13,447, working time, 75 days; Westinghouse, Church, Kerr & Co., New York, $12,990, 85 days; The R. T. Ford Co., Rochester, N. Y., $10,987, 125 days; THE G. & W. MFG. CO., 26 Cortlandt St., New York, $9,799 (awarded contract), 90 days; Edward P. Bates, Albany, N. Y., $13,214, 125 days; P. Delaney & Co., Newburgh, N. Y., $11,900, 90 to 120 days.

One bid was received on Sept. 30 for furnishing apparatus for water supply system at the Rochester State Hospital, Rochester, N. Y., that of the Hudson Engineering Co., 90 West St., New York, as follows: For installing water lifting apparatus complete, with capacity of 400,000 gallons per 24 hours, $5,350; for installing water lifting apparatus complete, with capacity of 250,000 gallons per 24 hours, $4,900. Working time, 50 days. T. E. McGarr is Secy. of Comn.; F. B. Ware is State Arch.

READING, PA.—Kurt W. Pruckert, Arch., Philadelphia, has let a contract to L. H. FOCHT & SONS, for the 4-story brick, stone and iron beer storage building, 72 × 88 ft., to be built in Reading for the Reading Brewing Co., at a cost of about $70,000.

MEADVILLE, PA.—James Knox Taylor, Superv. Arch., Treasury Dept., Washington, D. C., has let the contract for the construction of the public building at Meadville, Pa., to M. P. WELLS, of Philadelphia, at $77,437.

PHILADELPHIA, PA.—Bids are asked until 11 a. m., Oct. 22, by the Quartermaster, U. S. Marine Corps, Washington, D. C., for installing the necessary mechanical equipment in Extension "B," Depot of Supplies, Marine Corps, 1100 South Broad St., Philadelphia, Pa. Rankin, Kellogg & Crane, 1012 Walnut St., Philadelphia, are Archs.

PITTSBURG, PA.—We are officially advised that the FOUNDATION CO., 115 Broadway, New York has secured the contract and is now at work on the construction of the caisson piers for the foundations of the First National Bank Building, which is located at the corner of Fifth Ave. and Wood St., Pittsburg. The general contractor is JAMES L. STUART, 341 Sixth Ave., Pittsburg, and the work is in charge of D. H. Burnham & Co., Archs., Railway Exchange, Chicago, Ill.

WASHINGTON, D. C.—Bids were received as follows Oct. 6 at the office of James Knox Taylor, Superv. Arch., Treasury Dept., Washington, D. C., for the construction of a vault in the office of the Comptroller of the Currency, Treasury Dept., Washington, D. C.: York Safe & Lock Co., York, Pa., $33,214; Mosler Safe Co., Hamilton, Ohio, $33,393.

*WASHINGTON, D. C.—Bids are asked until noon, Oct. 16, by the Commissioners of the District of Columbia, (a) for foundations, concrete pile, and masonry work; (b) for ornamental iron work; (c) for the granite work for the Union Station Plaza Improvements, Washington, D. C.

WASHINGTON, D. C.—The Director of the Bureau of Standards, Washington, D. C., has awarded contract for the construction of a laboratory building for the Bureau to J. E. & A. L. PENNOCK, Land Title Bldg., Philadelphia, at their bid of $141,987. This firm filed the lowest bid. Wood, Donn & Demings, 808 17th St., N. W., Washington, are Archs. Noted fully on Oct. 1.

WASHINGTON, D. C.—James Knox Taylor, Superv. Arch., Treasury Dept., has awarded contract for the construction of an extension to the vault in the office of the Secretary of the Treasury, Washington to the MOSLER SAFE CO., Hamilton, Ohio, at $11,460.

D. H. Burnham & Co., Archs., Railway Exchange, Chicago, Ill., have submitted final plans for improvement of Washington Station Plaza, and contractors are invited to bid. Congress has appropriated $100,000 and Washington Terminal Co. probably will expend $50,000 additional. A Columbus memorial will occupy center of approach. Other features will include fountains, decorative flags, poles and monumental lamp-posts, whole enclosure to be surmounted by trees. Henry B. F. Macfarland and Edward M. Markham (acting), Comrs. District of Columbia.

CHARLOTTESVILLE, VA.—Bids were received by the Supervising Architect of the Treasury, Washington, D. C., for alterations to the post-office building at Charlottesville, Va.: Norcross Bros. Co., Worcester, Mass., $30,800; W. M. Seay & Son, Lynchburg, Va., $36,450; King Lumber Co., Charlottesville, Va., $31,267.

*MARIETTA, GA.—Bids are asked by James Knox Taylor, Superv. Arch., Treasury Dept., Washington, D. C., until 3 p. m., Nov. 4, for construction complete, of the U. S. post-office at Marietta.

CHATTANOOGA, TENN.—The Chattanooga Station Co., Fairfax Harrison, of Washington, D. C., Pres., which completed main building for station last June, will proceed with other necessary work in that connection, according to the "Manufacturers' Record." The company will install three 75-HP. boilers for steam heat for station and car-heating service, piping for conveying steam, gas and water. The CASEY-HEDGES CO., Chattanooga, has contract for boilers, and PECHMAN & PECHMAN, 611 Cherry St., Chattanooga, for piping. Bids are being considered for the electric wiring for six passenger sheds, each 700 ft. long, and 204 incandescent 50-CP. lights; bids are being received for erection of a 1-story six-room vitrified brick Pullman storage-house, 32x52 ft. BOISE & FOUST, 319 Poplar St., Chattanooga, have contract to build cement platforms under six passenger sheds for 14 tracks. Bids are invited for interlocking system for tracks in yards, estimated to cost from $60,000 to $70,000. Bids will be invited for coal trestle and coal storage bin at boiler-house. The ELLIS BUMPING POST MFG. CO., Chicago, Ill., has contract for bumping posts for 14 tracks. Grading has been started and the station company will lay cement walk in front building, under supervision of William Dunbar Jenkins, Engr., News Bldg., Chattanooga. Bids will be considered for furnishing main building. The company has trackage and switches to lay in passenger sheds and yards. Estimated cost of completed building is $400,000. Donn Barber, 24 East 23d St., New York, is Arch.

YOUNGSTOWN, OHIO.—A building is to be erected by the Reuben McMilan Free Library Association to cost about $100,000. Owsley & Boucherie, Wick Bank Bldg., Youngstown, are Archs.

CLEVELAND, OHIO.—About $1,000,000 will be invested by the Brotherhood of Locomotive Engineers in the construction of permanent headquarters in Cleveland, according to plans announced by Grand Chief Warren S. Stone. This sum includes the cost of the land. The Brotherhood will erect its home and office building at St. Clair Ave. and Ontario St. Construction will start next month. The building is to be twelve stories. It is to include an auditorium, seating 1,000 to 1,800 people.

Whitfield & King, Archs., 100 Fifth Ave., New York, have nearly completed plans for a 1-story branch library building for the Public Library Board, W. H. Brett, Librarian, Cleveland. The structure will cost $40,000.

INDIANAPOLIS, IND.—Plans will be received until Nov. 2 for the erection of a city hall building on the city's property at the corner of Ohio and Alabama Sts., at a cost of about $600,000. Charles G. Davis is Chn. Bldg. Com. (This is a postponement from Oct. 15.)

*CHICAGO, ILL.—Bids are asked until 11 a. m., Nov. 2, by John J. Hanberg, Comr. of Public Works, for the general work required in connection with the construction of the city-hall building to be erected on the west half of Block 39, original town of Chicago, according to plans and specifications of Holabird & Roche, Archs., Monadnock Block.

We are officially advised that the Chicago City Bank, South Halsted St., has awarded contract to OLSON BROS., 6501 Peoria St., Chicago, to construct a 3-story bank, 50 × 123 ft., to cost $120,000. Construction will be of steel, concrete and cut stone. Worthmann & Steinbach, 625 West Chicago Ave., are Archs.

CHICAGO, ILL.—We are officially advised that O. H. Perkins, Tribune Bldg., Chicago, is preparing preliminary plans for a commercial high school to be erected at Plymouth Pl. and Harrison St. for the Board of Education. The building will have 14 stories, steel skeleton, will be 100 × 175 ft. and will cost $1,000,000. T. J. Waters is Engr., Tribune Bldg.

James A. Patton, 160 Sherman St., is having plans prepared for the Printers Bldg. by H. B. Wheelock, Arch., Schiller Bldg. The building will have eight stories, 210 x 100 ft., and will cost $300,000. It will be of brick and steel construction.

We are officially informed that a 12-story building is to be put up at the corner of Market and Quincy Sts. by L. G. Fisher, Fisher Bldg. The building is to cover a lot that is 40 × 74 ft., and will cost $100,000. The walls will be of pressed brick with as much glass as possible. P. J. Weber, Fisher Bldg., is Arch.

ELGIN, ILL.—Bids are asked until 10 a. m., Oct. 20, by Robert Rew and Dr. P. M. Woodworth, Trustees, at the Illinois Northern Hospital for the Insane, for the construction of a 2-story fireproof hospital for acute insane and a 1-story mill construction industrial building. W. Carleys Zimmerman, Steinway Hall, Chicago, Ill., is State Arch.

MILWAUKEE, WIS.—Plans for the Cudahy apartment building to be erected on the lake front are being completed by Ferry & Clas, 419 Broadway, Milwaukee. Estimated cost, $300,000.

CHIPPEWA FALLS, WIS.—Bids were received as follows Oct. 6 at the office of James Knox Taylor, Superv. Arch., Treasury Dept., Washington, D. C., for the construction of a post-office at Chippewa Falls, Wis.: Appleton Construction Co., Appleton, Wis., $87,800; George R. Keachir, Madison, Wis., $68,525; Wisconsin Construction Co., Chippewa Falls, Wis., $68,000; J. W. Miller, St. Paul, Minn., $66,595; William J. Scott Building Co., Chicago, $71,282; Northern Construction Co., Milwaukee, Wis., $69,745; Barnes Bros., Hamilton, Ohio, $75,000; General Construction Co., Milwaukee, Wis., $71,600; Paul Riesen's Sons Co., Milwaukee, Wis., $72,000; Charles W. Gindele Co., Chicago, $69,700; Hanron Bros., Chicago, $72,450; Moore & Dauner, Kokomo, Ind., $84,260; P. M. Hennessey Construction Co., St. Paul, $68,475; Herbert T. Hazelton, Chicago, $70,000. Time, Dec. 1, 1909.

ST. PAUL, MINN.—Bids are asked until 3 p. m., Nov. 9, by James Knox Taylor, Superv. Arch., Washington, D. C., for the completion of the tower on the U. S. post-office, court-house and custom-house, St. Paul.

The Twin City Rapid Transit Co., W. J. Hield, Gen. Mgr., will construct its 3-story concrete fireproof storehouse at Snelling and University Aves., by day labor, having rejected all bids. It will be 100 × 300 ft., with electric lighting. Cost, $50,000.

FORT LEAVENWORTH, KAN.—Bids are asked by Maj. Thomas H. Slavens, Q. M., U. S. A., until 10 a. m., Oct. 14, for construction of one stable to accommodate 100 animals, at this prison.

OMAHA, NEB.—We are officially advised that the contract for general construction of Omaha View School, for the Board of Education of Omaha, was awarded on Sept. 25 to WALLACE H. PARRISH, at $93,953. This bid embraced the alternate design for a reinforced concrete first and second floor and second floor ceiling, as prepared by Albert C. Arend, Brandies Bldg., Omaha, Consult. Engr. The lowest bid for the I-beam and hollow tile construction for floors and ceiling, as prepared by the architect, was $98,763, and was submitted by the contractor.

SHERIDAN, WYO.—James Knox Taylor, Superv. Arch., Treasury Dept., Washington, D. C., has awarded contract for the construction of a post-office building at Sheridan, Wyo., to J. H. WIESE, South Omaha, Neb., at $131,420. Time, Dec. 31, 1909.

CAPE GIRARDEAU, MO.—Bids were received as follows Sept. 30 at the office of James Knox Taylor, Superv. Arch., Treasury Dept., Washington, D. C., for the construction of a post-office at Cape Girardeau, Mo.: Hiram Lloyd Building & Construction Co., St. Louis, Mo., $80,576; J. H. Johnson, Sedalia, Mo., $92,500; Barnes Bros., Hamilton, Ohio, $95,000; Claes S. Walin, Chicago, Ill., $86,725; Bedford Stone & Construction Co., Indianapolis, Ind., $77,300; J. C. Settle, St. Louis, Mo., $80,300; W. H. Fissell & Co., New York, $79,900; Hoosac Building & Construction Co., St. Louis, Mo., $85,500; M. Yeager & Co., Danville, Ill., $73,778. Time, Dec. 1, 1909.

HOUSTON, TEX.—We are officially advised that the contract for constructing the Harris County court-house at Houston has been awarded to H. L. STEVENS CO., Knoxville, Tenn., and Houston. The approximate cost of the building is $500,000. Building will be faced with granite and brick, and with reinforced-concrete floors. The contractor is taking estimates. Plans and specifications are on file at the office of Engineering News, New York.

EUGENE, ORE.—Bids are asked by James Knox Taylor, Superv., Arch., Treasury Dept., Washington, D. C., until 3 p. m., Nov. 7, for the construction (including plumbing, gas piping, heating apparatus, electric conduits and wiring), of the U. S. post-office at Eugene.

AGNEW, CAL.—The contract for the construction of two buildings for the insane at the Agnew State Hospital has been let to RECCA & ARBAN CONSTRUCTION CO., of San Francisco, for $85,000.

REDLANDS, CAL.—Preliminary plans for the proposed building of the University of Redlands have been completed. In the landscape arrangement places will be marked for about 25 buildings. At first it is expected that five will be erected and the new ones will be added every few years. The plans for the administration building show a structure that will cost from $60,000 to $80,000.

TORONTO, ONT.—The Shea Co., of Buffalo, N. Y., will erect a fireproof theater building at the corner of Victoria and Richmond Sts., with a seating capacity of 2,500 people and to cost approximately $250,000. Leon Lempert & Son, Cutler Bldg., Rochester, N. Y., are Archs.

HALIFAX, N. S.—The Board of School Commissioners has received the following bids for constructing a brick school Chebucto Road: Brookefield, Ltd., 12-room building, $78,486; 14-room building, $80,460; Faulkner & McDonald, 12-room building, $77,962; 14-room building, $79,964; S. Marshall & Son, 12-room building, $75,997; 14-room building, $78,791. The contract has been awarded to S. MARSHALL & SON for a 12-room building.

WATER SUPPLY—IRRIGATION.

(denotes that this work is advertised in Engineering News.)*

WAKEFIELD, MASS.—We are officially advised that plans are being prepared by William S. Johnson, C. E., 101 Tremont St., Boston, Mass., for improving the water supply here. Charles A. Dean is Chn. Water Comrs.

SPRINGFIELD, MASS.—The Water Department is having plans and specifications prepared for the Borden Brook reservoir, which will be contract No. 5, of the Little River Water Supply.

ALBANY, N. Y.—For itemized bids received on Oct. 1 for constructing reservoirs, dams, etc., in connection with the Barge Canal, see "Contract Prices" in this issue.

NEW YORK, N. Y.—Bids were opened on Sept. 24 by the Park Board for furnishing, delivering and laying water mains and appurtenances in Central Park, between 81st and 100th Sts., Borough of Manhattan. The lowest bid was submitted by the Hanover Construction Co., Park Row Bldg., at $30,513. Other bidders were: Atlanta Construction Co., $38,495; Thomas Crimmins Construction Co., $37,874; Bart Dunn, $36,825; Haggerty Construction Co., $45,678; McHasg-Barton Co., $30732; O'Leary & Flannagan, $43,328; Milton Construction Co., $34,767. Henry Smith is Pres. Bd.

MIDDLETOWN, N. Y.—The Erie R. R. Co. is to construct a reservoir and pumping station here. F. L. Stuart is Ch. Engr., 11 Broadway, New York. Work may not be started until next spring.

DELTA, N. Y.—Plans are being completed at the State Engineer's office, at Albany, for the construction of two reservoirs for canal water supply, one to be at Delta and the other at Hinckley. F. K. Skene is State Engr.

EAST ROCHESTER, N. Y.—The citizens have decided in favor of expending $150,000 for the acquirement of the sewer and water systems from private companies and $10,000 for the extension of the sewer system.

RENSSELAER, N. Y.—Leslie Allen, C. E., 24 De Graf Bldg., Albany, N. Y., is preparing plans for a reservoir for the Rensselaer Water Co., 852 Broadway St., Rensselaer, to be 250 × 400 × 10 ft. Bids will be called for late in the fall.

SYRACUSE, N. Y.—Bids will be received by Fred. Pierson, Clk. Bd. of Contract and Supply until Oct. 19 for the construction of the second Skaneateles Lake water conduit. Estimated cost, about $1,000,000.

*SHORTSVILLE, N. Y.—Contracts for constructing water-works, bids opened on Sept. 22, have been awarded as follows: To GOULD MFG. CO., Seneca Falls, for pumps, $5,040; CHARLES MILLAR & SONS CO., Utica, c.-i. pipe, $7,773; DES MOINES BRIDGE & IRON CO., Des Moines, Iowa, tank and tower, $4,200; DENNISTON & CO., Rochester, laying pipe, setting hydrants, superstructure of pump house and concrete work, $6,493; LUDLOW VALVE MFG. CO., Troy, for hydrants and gates, $1,267. N. Adelbert Brown is Consult. Engr., Rochester, N. Y.; F. C. Line is Asst. Village Engr., Shortsville.

CAMDEN, N. J.—Bids will be received until Oct. 21 by John S. Broome, Chn. Water Com., for furnishing a 24-in. Venturi meter tube, a direct-acting boiler feed pump and one improved open feed water heater.

LODI, N. J.—Lemuel Lozier, of Hackensack, N. J., is preparing plans for the construction of water-works. Estimated cost, about $80,000. Andrew D. Kerr is Boro. Clk.

PORTLAND, PA.—We are officially advised that FRITZ & PARTRIDGE, Dover, N. J., and Scranton, Pa., have been awarded the contract for the construction of water-works here, at $20,000.

*READING, PA.—H. E. AHRENS, Reading, has been awarded the contract by the Water Board for the construction of slow sand filters for the Maiden Creek water supply at $182,886. Bids were opened on Sept. 22. List of bidders noted last week.

PITTSBURG, PA.—The Common Council on Sept. 8 passed an ordinance appropriating $100,000 to be added to the $650,000 now available for constructing the filter beds.

RICHMOND, VA.—Bids are asked by E. E. Davis, Supt. Water-Works., until 5 p. m., Oct. 14, for furnishing and erecting machinery and apparatus for an electric pumping plant, including four centrifugal pumps, each of 4,000,000 gallons capacity per day; four 200-HP. electric motors, with necessary switchboard, wiring, pipes and water meters.

LYONS, GA.—See item under Light and Power Plants.

DECATUR, GA.—The city has voted $15,000 of bonds for the extension of the water-works.

DAYTONA, FLA.—We are officially advised that bids will be asked about Jan. 1, 1909, for the construction of water-works. D. D. & C. M. Rogers, Daytona, are Engrs.

CLARKSDALE, MISS.—Bids will be received until Oct. 9 by M. W. Purnell, City Clk., for a 6-in. well, 150-gallon flow.

CLEVELAND, OHIO.—Bids will be received until Oct. 8 by A. R. Callow, Secy. Bd. Pub. Ser., for furnishing material and constructing the steel work of floors and balconies in the engine houses of the Kirtland pumping station.

DAYTON, OHIO.—Bids will be received until Oct. 12 by the Board of Public Service, Wm. Budroe, Clk., for furnishing and installing in the water-works pumping station an air compressor and all appurtenances, including foundation, etc.

SHAWNEE, OHIO.—We are officially advised that the Board of Public Affairs has retained Bradbury & Shute, Hayden Bldg., Columbus, Ohio, as engineers in charge of the proposed water supply. Work will probably be started this fall.

READING, OHIO.—Bids will be received until Oct. 12 by the Board of Public Affairs, C. V. Dils, Clk., for furnishing and laying water pipe, special castings, valves, hydrants, etc., on Columbia, East, Second, Mechanic and Pearl Sts.

EAST LIVERPOOL, OHIO.—We are officially advised that the BROWNELL CO., of Dayton, Ohio, has been awarded the contract by the Board of Public Service for furnishing two 80-HP. horizontal standard Scotch boilers, with necessary fittings, complete and set up. Bids were opened on Sept. 30. A. S. Hughes is Clk. Bd.

ST. PAUL, MINN.—A bond issue for $50,000 has passed the City Council and will be used by the Board of Water Commissioners, John Caulfield, Secy., for the extensions of mains and conduits in the city.

BEMIDJI, MINN.—We are officially advised that the contract was awarded on Sept. 28 by the city for the construction of a steel tower, 120 ft. high, supporting a steel hemispherical bottom tank of 100,000 gallons capacity to the CHICAGO BRIDGE & IRON WORKS, at $6,380, including connection with mains 50 ft. distant. M. Q. Stoner is City Engr.

ELLINWOOD, KAN.—Bids will be received until Oct. 12 for the construction of water-works. W. K. Palmer Co., of Kansas City, Mo., are Engrs.

LOWER BRULE, S. DAK.—Bids are asked by the Commissioner of Indian Affairs, Washington, D. C., until 2 p. m., Oct. 20, for constructing a well at Lower Brule Agency. C. F. Larrabee is Acting Comr.

*HELENA, MONT.—Bids will be received at the City Hall, Helena, until noon, Oct. 29 for the furnishing of all material and the construction of a water-works system, reservoir pipe line, and distribution system for the city, all according to plans and specifications.

Work involves approximately ten miles of wooden conduit, 40 miles of c.-i. mains, 250 hydrants, 400 gate valves, specials, etc., and a storage reservoir to hold approximately 5,000,000 gallons, together with all appurtenances. Plans and specifications, forms of contract and proposals may be seen at the City Clerk's Office and copies of all thereof obtained upon payment of $5. J. A. Mattson is City Clk.

ALBA, MO.—Bids will be received until Oct. 10 by W. F. Barnett, City Clk., for furnishing material and constructing the following: A steel tower and tank, 50,000 gallons capacity; 4,154 lin. ft. 4, 6 and 8-in. c.-i. pipe, 2,675 ft. 2-in. galvanized pipe, twelve fire hydrants, concrete foundation, four concrete piers and foundation for four elbow of riser pipe, all specials, tees, crosses, reducers, valves, boxes, etc. Michel-Cooke Engineering & Construction Co., Joplin, Mo., may be addressed for plans and specifications.

FORT SAM HOUSTON, TEX.—TRUEHEART & JACKSON, San Antonio, Texas, have been awarded the contract for constructing the extension to water distributing system for new cavalry addition, Fort Sam Houston, at $11,273. L. J. Fleming is Constructing Q. M.

OAKLAND, CAL.—Bids for the construction of the pumping plant to be installed at the Willows on Lake Merritt for the auxiliary salt water system have been opened. The lowest bid was that of the Healy-Tibbitts Co., 268 Market St., San Francisco, Cal., at $21,830. The other bidders were: Clinton Fire Roofing Co., $24,375; Rickon-Ehrhart Engine Co., $22,594; Couchet & Thurston, $26,990; Frank A. Sullivan, $34,751 and William Bruce, $29,375.

OGDEN, UTAH.—The citizens have voted to purchase the plant of the Ogden Water-Works Co., and it is reported will on Jan. 1 take over the plant and expend about $59,000 in improving it. A. F. Parker is City Engr.

OAKVILLE, ONT.—The Oakville Water-Works and Electric Commission has awarded the contract for constructing the water system to MOOGK & CO., of Waterloo, Ont.

LETHBRIDGE, ALTA.—See under Light and Power Plants.

VICTORIA, B. C.—Bids will be received until Oct. 26 for furnishing 3,500 water meters for the water-works. William Scowcroft is Acting Purchasing Agt.

SEWERAGE.

(denotes that this work is advertised in Engineering News.)*

PORTSMOUTH, N. H.—Bids will soon be asked by the Council for the reconstruction of the Richard Ave. sewer. W. A. Grover is Engr.

NEW HAVEN, CONN.—Bids will be received until Oct. 9 by C. W. Kelly, City Engr., for constructing sewers in portions of Monroe, Alton and Irving Sts.

AUBURN, N. Y.—Bids will probably be asked for about May 1, 1909, for the construction of sewers in Wards 1, 6 and 10, and for a sewage disposal plant. Estimated cost, $110,000. J. S. Hanlon is City Clk.

SYRACUSE, N. Y.—R. C. Allen, City Engr., has estimated the cost of constructing a 24-in. sewer in East Colvin and other streets at $45,000.

*WEST POINT, N. Y.—We are officially advised that bids were received on Sept. 29 by Maj. J. M. Carson, Jr., Q. M., U. S. A., for the construction of a storm brick sewer as follows: Stanley S. De Novens Co., 827 Dean St., Brooklyn, N. Y., $5,500; Charles T. Wills, Inc., 156 Fifth Ave., New York, $4,884; E. A. MATTHEWS, 13 Park Row, New York, $3,200 (awarded contract).

*RYE, N. Y.—Plans and specifications are on file at the office of Engineering News, New York, for the construction of sanitary sewers and sewage disposal plant. Bids are asked until Oct. 28.

PHILADELPHIA, PA.—Bids are asked until noon, Oct. 14, by George R. Stearns, Dir. Pub. Wks., for the construction of branch sewers.

WILKES-BARRE, PA.—Bids are asked until noon, Oct. 26, by Fred H. Gates, City Clk., for constructing about one mile of circular brick sewer. B. K. Finch is City Engr.

EDWARDSVILLE, PA.—The Borough Council has awarded the contract to J. A. HARKNESS for the construction and maintenance for a period of three years of a system of public sewerage on Church St., Hillside Ave., Swallow St. and Summit Ave. and for the disposal of the waste water and other sewage matter at $6,621.

WASHINGTON, D. C.—Bids are asked until noon, Oct. 12, by the Commissioners of the District of Columbia for the extension of the 14th St., S. E., trunk sewer across Water St.

SELMA, ALA.—George Vice, Demopolis, Ala., has submitted the lowest bid at $7,455 for the construction of the sanitary sewer 2½ miles long in North Selma, main sewer to be of 12-in. pipe. Julien Smith is City Engr.

*MERIDIAN, MISS.—The RUBUSH-DOBBS CONSTRUCTION CO. has secured the contract for constructing a concrete storm sewer in Eighth St. and 25th Ave. Bids were opened on Sept. 25. W. S. Wetmore is City Engr.

*LOUISVILLE, KY.—Bids are asked until noon, Oct. 16, by the Commissioners of Sewerage, for the construction of the Breckenridge sewer, Contract No. 13, of the comprehensive system of sewerage. The work consists mainly of constructing a sewer of concrete as follows: 1,223 ft., 54-in. diameter; 48 ft., 51-in. diameter; 484 ft., 45-in. diameter; the average depth of cut, 13.4 ft.; approximately 740 cu. yds. of concrete. Plans and specifications may be seen at the office of the Commissioners. Advertised last week. J. B. F. Breed is Ch. Engr. Comrs.

LINDEN HEIGHTS, OHIO.—It is proposed to construct a storm sewer system this fall. Bradbury & Shute, Hayden Bldg., Columbus, Ohio, are Village Engrs.

CIRCLEVILLE, OHIO.—Bids will be received until Oct. 12 for constructing sewage purification plant for Pickaway County Infirmary. N. C. Bohnert is County Audr.

NEWARK, OHIO.—The State Board of Public Works has let the contract for a drainage sewer along the banks of Buckeye Lake for the benefit of cottagers. The following bids were submitted: F. H. Kinney & Son, Newark, Ohio, $4,983; Winchell & McDaniels, Columbus, Ohio, $4,957; A. W. Schneider, $6,227; Kinnear Bros., Columbus, Ohio, $4,792; J. H. SPURGEON, Kirkersville, Ohio, $3,492 (awarded contract).

CLEVELAND, OHIO.—Bids will be received at the office of the Secretary of the Board of Public Service, 105 City Hall, until noon, Oct. 13, for the construction of sewers in the following streets: East 67th St., between Harvard Ave., S. E., and Clement Ave., S. E., with a temporary outlet into Burke Brook; furnishing, driving piling and protecting the outlet of the East 40th St. sewer at Kingsbury Run. W. J. Springborn is Pres. Bd.

STEUBENVILLE, OHIO.—Bids are asked until noon, Oct. 12, by the Board of Public Service for the construction of sewers in Seventh St. and Linden Ave. H. G. Simpson is Clk. Bd.

*OXFORD, OHIO.—We are officially advised that bids were received as follows on Sept. 29 by the Council for the construction of sanitary sewers here, the work consisting of approximately the following amounts: 40,700 lin. ft. of 8-in., 7,000 lin. ft. of 10-in., 10,000 lin. ft. of 12-in., 3,500 lin. ft. of 15-in. sewer; 120 manholes, 29 lampholes; 29 flush tanks; 11,410 lin. ft. excavation under 5 ft.; 22,082 lin. ft. excavation, 5-7 ft.; 11,815 lin. ft. excavation, 7-9 ft.; 2,540 lin. ft. excavation, 9-11 ft.; 2,070 lin. ft. excavation, 11-13 ft.; 870 lin. ft. excavation, 13-15 ft.; together with all necessary Y branches and appurtenances: M. O'Herran & Co., Pittsburg, Pa., $43,374; John B. McLane, Newport, Ky., $49,073; E. W. Boston, Cincinnati, Ohio, $48,642; McCarthy Bros., Cincinnati, $51,361; Henry Spinach, Waterbury, Conn., $53,345; Paul & Kirchner, Dayton, Ohio, $50,326; Irwin Bros., Greenville, Ohio, $50,301; C. C. Sauer, Chicago, Ohio, $48,662; C. T. McCracken, Columbus, Ohio, $54,557; Bennett Construction Co., Cincinnati, $59,766; Pease, Buzatt & Co., Indianapolis, Ind., $52,014; John B. Truman, Lafayette, Ind., $53,971; Kaps & Brehm, Portsmouth, Ohio, $61,743; Northwestern Construction Co., Franklin, Pa., $44,819; F. C. Morgan, Vincennes, Ind., $45,942; Tripper & Son, Peru, Ind., $54,338; E. M. Gephart & Co., Dayton, $48,494; Harmon & Sieverling, Springfield, Ohio, $46,634; Melcher & Morrison, Cincinnati, Ohio, $92,651; F. R. Stone, Lima, Ohio, $40,796, deducting $1,495 for house connections; Price & Hurley, Marion, Ohio, $51,396; Thomas R. Strack, Cincinnati, $55,734; REESE & LARKIN, Dayton, $38,990; deducting $1,230 for house connections (awarded contract); Andrews Asphalt Paving Co., Hamilton, Ohio, $59,641; Evan Evans, Cincinnati, $49,310; D. P. Boston is Clk. Itemized list of bids will be given under Contract Prices next week.

HILLSDALE, MICH.—Bids will be received until Oct. 13 by the city for [illegible] of pipe sewers. Estimated cost of construction about $5,000. S. H. Moore is City Clk.

ST. JOSEPH, MICH.—Bids are asked by Harry L. Murphy, City Clk., until 2 p. m., Oct. 14, for furnishing all material and constructing sewer No. 8 and [illegible] the southern portion of the city sewer for ft., the work to be done according to specifications, plans and diagrams about 11,000 file in the office of the City Clerk.

SPRINGFIELD, MINN.—Bids are asked until 8 p. m., Oct. 13, by the [illegible] for the construction of lateral sewers, for the [illegible] sen, 514-515 German-American Oscar Clausen Bank Bldg., St. Paul, Minn., is Engr.

TWO HARBORS, MINN.—The City Council on Sept. 21 awarded the contract to HAUGSTEN & JOHNSON, Two Harbors, for the construction of a sewer on Third Ave., at $5,816.

WELLINGTON, KAN.—The Council on Sept. 22 awarded the contract for constructing the sewers, laterals, in sewer district No. 2 to the MUNSTRUCTION CO., at $6,563. AL CONother bids, one for $7,550 and were two $8,000. The contract calls for other for 10-in. sewer pipe and 7,090 ft. of 8-in., 20 manholes, four flush tanks, eight lampholes and 222 junctions.

FORT SAM HOUSTON, TEX.—[illegible]LING & HUGHES, of San Antonio, Tex., have secured the contract at $18,566 for constructing a drainage system and extensions to sewer system for new cavalry addition, Fort Sam Houston. L. J. Fleming is Constructing Q. M., U. S. A.

LAWTON, OKLA.—Bids will be received until Oct. 12 for the construction of sewers here. Estimated cost, about $40,000. John D. Kenwood, of Lawton, is Engr.

STERLING, COLO.—S. G. MAGDEN, of Des Moines, Iowa, has been awarded the contract by the town for constructing ten miles of sewer at about $43,000.

SPOKANE, WASH.—The following are the bids opened by the Board of Public Works on Sept. 22 for constructing the First Ward sewer district No. 1: John Fife, $54,936; J. A. Clark, $49,000; Foster & Hindle, $56,498.

SEATTLE, WASH.—Bids will be received until Oct. 24, by the Board of Public Works for the construction of sewers in various streets. Estimated cost, $500,000. R. H. Thomson is City Engr.

SEATTLE, WASH.—Bids were received on Sept. 26 by the Board of Public Works as follows for the improvement of Mount Baker Boulevard and other streets by constructing sewers: PUGET SOUND BRIDGE & DREDGING CO., 95 Yeser Way, Seattle, $117,567 (awarded contract); Keogh & Jassen Co., Seattle, $145,937.

OAKLAND, CAL.—Bids are asked until 10 a. m., Oct. 14, by the Board of Public Works, Walter B. Fawcett, Secy., for extending storm culvert from Excelsior Ave. to Lake Shore Ave.

SELMA, CAL.—Bids will be received by the Board of Town Trustees until Nov. 2 for the construction of a sanitary sewer system of vitrified salt glazed sewer pipe. R. C. Gibbs is City Clk.

WELLAND, ONT.—Bids were opened as follows by the Town Council on Sept. 21 for the construction of the east end sewer system, the work embracing a trunk sewer on Queen St., East Main, Ross and Major Sts., 5,000 ft. in length, and branch sewers in Garner Ave., 1,970 ft., Burgar St., 2,056 ft., Welland St., 1,550 ft., Patterson Ave., 1,600 ft.: R. W. Harcourt, $53,000; J. F. CONNOLLY, 194 Jamestown Ave., Toronto, Ont., $51,000 (awarded contract); Cook & Lorenzo, $55,034; M. A. Piggott, $59,900. Engineer's estimate, $59,000.

PRESTON, ONT.—The CONCRETE ENGINEERING & CONSTRUCTION CO., Stair Bldg., Toronto, has been awarded the contract for constructing sewers here.

BRAMPTON, ONT.—The contract for 5,000 ft. of 8 and 10-in. pipe sewers, bids opened Sept. 19, has been awarded to the J. H. McKNIGHT CONSTRUCTION CO., Adelaide St., East, Toronto, at about $4,200.

CHIHUAHUA, MEX.—Plans will probably be completed by Nov. 1 for the improvement and extension of the sewer and water systems here.

GARBAGE DISPOSAL.

(denotes that this work is advertised in Engineering News.)*

FORT JAY (New York post-office), N. Y.—Bids will be received until Oct. 8 by the Quarter Master, Ft. Jay, Governor's Island, N. Y. Harbor, for repairs to be made at the crematory here.

NEW YORK, N. Y.—Bids are asked until noon, Oct. 20, by Foster Crowell, Comr. St. Cleaning, for furnishing all the labor and materials required for the removal of snow and ice in the Boroughs of Manhattan, the Bronx and Brooklyn.

READING, PA.—Bids will be received until Oct. 12 by the Department of Garbage, in care of Caleb Weidner, City Clk., for the collection, removal and disposal of all garbage and offal and dead animals for a period of three and five years. Elmer H. Beard is City Engr.

STREETS AND ROADS.

(denotes that this work is advertised in Engineering News.)*

LEE, MASS.—The contract for constructing a half-mile of gravel road commencing at the Strickland House in East Lee has been awarded by the State Highway Commission to M. L. CARMARCO at $4,333.

NOR... MASS.—EDWARD J. ROURKE was awarded the contract on Sept. 22 by the State for the construction of three miles and ... state highways here, at about $17,000.

HAR... CONN.—The following contracts for state road work, bids for which were opened at the office of the State Highway Commissioner on Sept. 29, have been awarded: Town of North Stonington, 10,600 lin. ft. of gravel and gravel-telford road, with ... gutters and timber work at railroad crossing, to EDWARD McKNIGHT, Westerly, R. I., at 97 cts. per lin. ft. for gravel-telford and ... per lin. ft. for gravel-telford and ... cobble and timber work. Other bidders were: O. T. Benedict, Pittsfield, Mass., ... $1.65 and $50; Pierson Engineering & Construction Co., Bristol, $1.15, ... $1; Amos Bridge's Sons, Hazardville, ... $1.29, $1.69 and $50; Lane Construction Co., Meriden, $1.23, $1.73 and $100; ... Putnam, $1.28, $1.45 and $30; ... & Sons, Middletown, $1.53, $1.94 and ... T. H. Gill Co., Winter Hill Station, Mass., $1.21, $1.75 and $150; ... one 15-in., two 18-in. and one 24-in. culverts required. Town of Waterford, 4,874 lin. ft. of graded road, with gravel and telford base, to PIERSON ENGINEERING & CONSTRUCTION CO., ... $8,000, 30 cts. per lin. ft. for rail-Bridge & Construction Co., Bristol; Amos ... 60 cts. per lin. ft. for telford. Other bidders were: Edward McManus, Waterbury, ... 40 cts. and $1.83; O. T. Benedict, Pittsfield, $17,250, 40 cts. and 50 cts.; Lane Construction Co., Meriden, $17,190, 45 cts. and ... cts.; T. H. Gill Co., $10,937, 30 cts. and ... cts. Town of Franklin, 8,100 lin. ft. gravel and gravel-telford, to WILLIAM B. WILCOX, Mystic, Conn. Other bidders were: O. T. Benedict, Pittsfield, Mass.; Pierson Engineering & Construction Co., Bristol; Amos Bridge's Sons, Hazardville; Lane Construction Co., Meriden; Ahern Bros., Putnam; Antonio Vito, Woodstock; A. Brazos & Sons, Middletown; T. H. Gill Co., Boston, Mass. One 24-in., one 20-in. and one 12-in. tile culverts required. Town of Norwich, 8,000 lin. ft. macadam and macadam-telford, to A. BRAZOS & SONS, Middletown, at $1.86 per lin. ft. for macadam and $2.36 for telford. The Town of Norwich bid $2 and $2.08.

BROOKLYN, N. Y.—Bids are asked by Bird S. Coler, Boro. Pres., until 11 a. m., Oct. 21, for regulating and repairing with sheet asphalt, Class B, on a concrete foundation various streets; also on a grouted stone block foundation; for regulating and paving and regulating and repaving with asphalt, granite, iron slag and Medina sandstone on a concrete foundation certain streets.

NEW YORK, N. Y.—Bids are asked until 10.30 a. m., Oct. 19, by Nicholas J. Hayes, Fire Comr., for furnishing all the labor and materials required for repairs to asphalting at various company quarters in the Boroughs of Manhattan and the Bronx.

NEW YORK, N. Y.—Bids are asked by the Park Board until 3 p. m., Oct. 15, for furnishing and delivering new 5-in. bluestone curbstones along Broadway, where required, between 65th and 80th Sts., Borough of Manhattan, City of New York. Henry Smith is Pres.

NEW YORK, N. Y.—Bids are asked until 3 p. m., Oct. 15, by the Park Board for paving with asphalt tiles the ends of the parks in Broadway, between 60th and 80th Sts., the Borough of Manhattan, City of New York. Henry Smith is Pres. Bd.

ALBANY, N. Y.—The Board of Contract and Supply, Albany, has awarded to JOHN M. HOLLER, of Albany, the contract for the improvement of Orange St., from North Pearl St. to Lark St., at $33,675. Walter Melius is City Engr.

SCHENECTADY, N. Y.—Contracts for grading Oakwood Ave. and Willett St. were awarded on Sept. 23 by the Board of Contract and Supply to T. R. CRANE and ALPHEUS G. DAVIS, respectively. Bids were opened on Sept. 16.

WALLINGTON (Rutherford post-office), N. J.—The JOHN T. HARROP CO., of Garfield, N. J., was awarded the contract to curb and gutter Maple Ave., from Lester St. to Park Way on Sept. 26 by the Council. Bids from James Maybury & Son and the Union Building & Construction Co. were also received. John J. Polmann is Supt. Pub. Wks.

PITTSBURG, PA.—Bids will be received by F. P. Booth, County Controller, at Pittsburg, until Oct. 22, for improving Pangburn Hollow Road a distance of about 1.8 miles, and Freeport Road, Section No. 5, a distance of about 2¼ miles.

HARRISBURG, PA.—Bids are asked until Oct. 22 by the State Highway Department for the construction of roads aggregating 42,286 ft. Joseph W. Hunter is State Highway Comr.

TARENTUM, PA.—Bids are asked until 2 p. m., Oct. 10, for the paving, grading and curbing of East Eighth Ave., from Ross St. to Corbet St. Estimated quantities as follows: Excavation, 2,800 cu. yds.; brick paving, 3,600 sq. yds.; curbing, 2,300 lin. ft. Plans and specifications may be seen at the Borough Bldg., Tarentum.

YORK, PA.—Bids are asked until Oct. 16 by the State Highway Department, Harrisburg, for constructing 27,000 ft. of road with three bridges in Fawn Township.

MEDIA, PA.—Bids are asked until Oct. 16 by the State Highway Department, Harrisburg, for constructing two sections of the Tanguay Road, 9,800 ft., and 9,817 ft., with three bridges, in Thornbury Township.

CARLISLE, PA.—Bids are asked until Oct. 16 by the State Highway Department, Harrisburg, for constructing 3,600 ft. of road with one bridge in Camp Hill Borough.

HAGERSTOWN, MD.—Bids are asked until Oct. 13 by Washington County for grading and macadamizing about 2½ miles of Clarion Road. John E. Wagaman is County Clk.

WASHINGTON, D. C.—See item under Buildings.

WASHINGTON, D. C.—The contract for the construction of a concrete walk, brick wall, drains, iron fence, grading, etc., at the parade grounds, marine barracks, Washington, D. C., has been awarded to ARTHUR COWSILL, of Washington, D. C., at $8,350.

WHEELING, W. VA.—GEORGE W. LEMON was awarded the contract on Sept. 24 by the Board of Public Works for paving, at the following prices: Excavating, 50 cts. per cu. yd.; gravel fill, $1.05 per cu. yd.; sanding joints, 5 cts. per sq. yd.; and laying block, both Bessemer and asphalt, 15 cts. per sq. yd. Other bids received were J. E. Wright Co., excavating, $1.25 per cu. yd.; gravel fill, $1.37 per cu. yd.; sanding, 3½ cts. per sq. yd., laying Bessemer block, 15 cts., and asphalt block 20 cts. per sq. yd.; R. B. McColloch, excavating, 53 cts.; graveling, $1.20; sanding, 4 cts.; laying Bessemer block, 18 cts., and asphalt, 23 cts.

SALISBURY, N. C.—Bids are asked by Maj. M. Gray Zolinski, Q. M., U. S. A., Washington, D. C., until 11 a. m., Oct. 16, for constructing roadway, sidewalks, etc., at the Salisbury National Cemetery. Plans and specifications can be seen at Washington or at the office of the Superintendent, Salisbury National Cemetery.

RALEIGH, N. C.—The Greater Raleigh Land Co., F. K. Ellington, Vice-Pres., has had plans prepared by Prof. W. C. Riddick, C. E., Raleigh, for the construction of sidewalks and sewers. It is proposed to lay 1,900 sq. yds. of granolithic sidewalk and 6,000 ft. of 6 and 8-in. sewers and build concrete or iron bridge 40x100 ft. Estimated cost of improvements including streets, sidewalks and sewers, $17,000. Bids for constructing sidewalks and sewers will be received Oct. 10.

JACKSONVILLE, FLA.—Bids are asked by the Board of Public Works until 2:30 p. m., Oct. 12, for grading an area approximately 666 sq. yds., and for furnishing and placing in position approximately 600 lin. ft. stone curbing, and for furnishing on the street and for laying 666 sq. yds. more or less, of vitrified paving blocks of some standard brand, with which to pave Talleyrand Ave., 20 ft. wide, north from Marshall St., for a distance of 300 ft. Philip Prioleau is City Engr.

LOUISVILLE, KY.—The contract for paving Bank St., from 33d St. to 37th St., with asphalt, was awarded on Sept. 24 to the BARBER ASPHALT PAVING CO., of Louisville, by the Board of Public Works, at $23,000. J. P. Claybrook is City Engr.

FORT THOMAS, KY.—Plans and specifications for roadway and sidewalks to be constructed in the vicinity of the Quartermaster's stables at this post, are on file at the office of Engineering News, New York. Bids are asked until Oct. 12.

CINCINNATI, OHIO.—Bids are asked until noon, Oct. 23, by the County Commissioners, Fred. Dreihs, Clk., for the improvement of Duck Creek Road from Cincinnati corporation line to Dearfield Road, Columbia Township.

TOLEDO, OHIO.—The Board of Public Service on Sept. 25 awarded the following paving contracts: Scottwood Ave., between Monroe St. and Delaware Ave., to JOSEPH HENREDDY, of Chicago, Ill., at $11,917.35. Sheet asphalt will be used. The bid was $1.19 per yd. Fitchland Ave., from Detroit to Smead Ave., M. F. O'SULLIVAN, of Toledo, $6,597. Vitrified brick will be used. Earl St., from East Broadway to Woodville, same, $4,915. Vitrified block. Because some residents want sheet asphalt and others creosoted block, contracts for the repaving of Glenwood Ave. were not awarded.

COLUMBUS, OHIO.—Bids are asked until noon, Oct. 14, by the Board Public Service for the improvement of various streets. Edward W. Hirsch is Secy. Bd.

Bids are asked until noon, Oct. 13, by the County Commissioners of Richland County, for grading and macadamizing 3.25 miles of road in Springfield Township. Specifications, plans and profiles are on file in the office of the County Commissioners in Mansfield, Ohio, and at the State Highway Department. Copies of specifications may be obtained at the latter office. James C. Wonders is State Highway Comr.

MARIETTA, OHIO.—Bids were received as follows on Sept. 24 by the Board of Public Service for paving (a) Warren St.; (b) Sacra Via St.; (c) St. Clair St.: L. T. Cisler, (a) Marietta block, $1.08 sq. yd.; relaying old paving, 35 cts. sq. yd.; resetting old curb, 12 cts. ft.; Bedford limestone, 40 cts. ft.; Berea sandstone, 41 cts. ft.; catch basins, $23 each; 12-in. drain pipe, 70 cts. ft.; 15-in. drain pipe, 81 cts. ft.; (b) Marietta block, $1.03 sq. yd.; resetting old curb, 12 cts. ft.; relaying old paving, 30 cts. sq. yd.; Bedford limestone, 40 cts. ft.; Berea sandstone, 41 cts.; catch basins, $23 each; 12-in. drain pipe, 66 cts. ft.; 15-in. drain pipe, 76 cts.; 20-in. drain pipe, 96 cts.; (c) Sterling or Cisler block, $1.02 sq. yd.; resetting old curb, 12 cts. ft.; relaying old paving, 25 cts. sq. yd.; Bedford limestone, 40 cts. ft.; Berea sandstone, plain, 41 cts. ft.; catch basins, $23 each; 10-in. drain pipe, 43 cts. ft. Putnam & Price, (a) Sterling and Cisler block, $1.07 sq. yd.; Townsend block, $1.09 sq. yd.; tar filler, 20 cts. extra; Bedford limestone, 42 cts. ft.; Berea sandstone, plain, 41 cts. ft.; Berea sandstone, machine dressed, 42 cts. ft.; catch basins, $23; 12-in. drain pipe, 55 cts. ft.; 15-in. drain pipe, 65 cts.; (b) Sterling and Cisler block, $1.04 sq. yd.; Townsend block, $1.05; tar filler, 20 cts. extra; Bedford limestone, 41 cts. ft.; Berea sandstone, plain, 40 cts.; Berea sandstone, machine dressed, 41 cts. ft.; catch basins, $23; 12-in. drain pipe, 50 cts. ft.; 15-in. drain pipe, 60 cts.; 20-in. drain pipe, 85 cts.; (c) Marietta block, $1.07 sq. yd.; tar filler, 20 cts. extra; Bedford limestone, 41 cts. ft.; Berea sandstone, plain, 43 cts.; Berea sandstone, machine dressed, 42 cts.; catch basins, $23; 10-in. drain pipe, 45 cts ft. W. C. Peters, (a) Marietta block, $1.11 sq. yd.; tar filler, 20 cts. extra asphalt filler, 45 cts. extra; relaying old work, 40 cts. sq. yd.; resetting old curb, 8 cts. ft.; Bedford limestone, 47 cts.; Berea sandstone, 42 cts.; catch basin, $25; 12-in. drain pipe, 50 cts. ft.; 15-in. drain pipe, 80 cts.; (b) Marietta block, $1.02 sq. yd.; tar filler, 20 cts. extra; asphalt filler, 45 cts. extra; relaying old work, 40 cts. sq. yd.; resetting old curb, 8 cts. ft.; Bedford limestone, 46 cts.; Berea sandstone, 40 cts.; catch basin, $25; 12-in. drain pipe, 50 cts. ft.; 15-in. drain pipe, 80 cts.; 20-in. drain pipe, $1; (c) Marietta block, $1.08 sq. yd.; tar filler, 20 cts. extra; asphalt filler, 45 cts. extra; relaying old work, 40 cts. sq. yd.; resetting old curb, 8 cts. ft.; Berea sandstone, 40 cts.; catch basins, $25; 10-in. drain pipe, 25 cts. ft.

ARCADIA, OHIO.—HENNESSEY BROS., of Napoleon, Ohio, have been awarded the contract for paving the principal street of Arcadia at $10,616. There were seven other bidders for the work.

HANOVERTON, OHIO.—The contract for grading and paving of 1.28 miles of state road in Hanover Township has been awarded by the County Commissioners to WILLIAM N. WRIGHT, of Lisbon, Ohio, at $12,842, the lowest of twelve bids. The new road to be built begins at the termination of Canal St. in Hanoverton and extends to Kensington and will be paved with brick.

CLEVELAND, OHIO.—Bids are asked until 11 a. m., Oct. 21, by the County Commissioners for the improvement of State road No. 5 by grading, draining and improving the same from the north line of Royalton Township south to the Aikens road in Royalton Township. A. B. Lea is County Surv.

DAYTON, OHIO.—Bids are asked until noon, Oct. 9, by W. A. Budroe, Clk., Bd. Pub. Ser., for setting combined cement curb and gutter, grading and paving the sidewalks with cement, on the unfinished portions of certain streets.

CINCINNATI, OHIO.—Bids are asked by the County Commissioners until noon, Oct. 16, for the improvement of several roads. Fred. Dreihs is Clk. Bd.

The KIRCHNER CONSTRUCTION CO. was awarded the contract by the Board of Public Service Sept. 24 for paving Torrence Road, between Columbia Ave. and the Pennsylvania Ry., at $4,924.

WABASH, IND.—Bids are asked until 6 p. m., Oct. 12, by Fremont M'Lees, City Clk., for the completion of the work for the construction of cement sidewalks on the south side of Spring St., from a point 450 ft. west of Manchester Ave. to Manchester Ave.

MUNCIE, IND.—No bids were submitted to the Board of Pub. Works on Sept. 25 for paving several sections of streets, with brick.

SOUTH BEND, IND.—The Board of Public Works awarded contracts on Sept. 23 for sidewalks, as follows: Michigan Ave. and Division St., TESER & ROBARGE; LaSalle and Colfax Aves., W. H. FRIES; Jefferson St., Portage Ave. and Main St., H. N. BARNES.

The contract for the paving of the alley west of Lafayette St. with brick was let to C. H. DEFREES.

EAST ST. LOUIS, ILL.—Bids are asked by Board Public Improvements until noon, Oct. 10, for the improvement of excavation curb, etc. Frank B. Hanna, Clk. Bd.

DAVENPORT, IOWA.—The Board of Local Improvements awarded the contract on Sept. 24 for paving Twelfth St., from First to Fourth Ave., and for sidewalks in the Second Ward, to the TRI-CITY CONSTRUCTION CO., at $1.62 per sq. yd. and 50 cts. for sidewalks.

HELENA, MONT.—The TWO MIRACLES CONCRETE CO. has been awarded the contract by the City Council for the construction of sidewalks on both sides of Grand St. and Sixth Ave. The bids submitted on the work and the bidders were as follows: Louis Johnson, $8,543; William McMullan, $8,026; Poore & McKowan, $7,627; Two Miracles Concrete Co., $7,516.

LITTLE ROCK, ARK.—I. P. SHELBY, Little Rock, has been awarded the contract for paving West Tenth St. with brick paving blocks.

MOUNT VERNON, WASH.—The contract for improving Second, Division and Fulton Sts. has been let to C. E. ANDRES.

HOQUIAM, WASH.—The Council has received no bids for the improvement of Eighth and I Sts.

SPOKANE, WASH.—The Board Public Works has awarded contracts as follows: Grading, Illinois, 27th and 29th Aves., Madison and Sheridan Sts., to MITCHELL BROS., 1222 Third Ave., at $24,403; Carlisle and 15th Aves., to JOHN FIFE, at $9,788; 17th Ave., between Perry and Crestline Sts., to THOMAS MALONY, at $11,884; and 17th Ave., between Crestline and Ray Sts., to JOHN H. McALLISTER, 111 Mill St., at $9,737.

BELLINGHAM, WASH.—WALKER & McCUE have submitted the only bid for improving Fifteenth St., from Douglass to Garden St., at $7,792, and were recommended for award by the Board of Public Works.

SEATTLE, WASH.—R. H. Thomson, City Engr., has reported the estimated cost of the following street improvements: East Newton St. and other streets, grading, $11,000; Eastlake Ave., concrete walks, $16,000.

EUGENE, ORE.—Bids for paving, constructing cement curbing and drainage have been opened and the following contracts let to the lowest bidders, as follows: For paving West Eighth St., from Charnelton to Monroe St.; for paving East Seventh St., from Oak to High St., and for paving 160 ft. of the alley between Sixth and Seventh Sts., from Williamette St. east, to the WARREN CONTRUCTION CO.

The contract for the curbing on West Eighth St. and East Seventh St. was let to T. H. ELLIS, at 35 cts. for straight and 60 cts. for curved curbing.

WOODLAND, CAL.—The contract for macadamizing South First St. was let on Sept. 22 by the City Trustees to W. F. HANRAHAN, at $12,061.

CORONA, CAL.—The City Trustees have awarded the contract to the HIGHWAY CONSTRUCTION CO. for the improvement of Palm Ave. and the southwest portion of Grand Boulevard, at $26,123.

SALT LAKE CITY, UTAH.—We are officially advised that bids were received as follows on Sept. 25 for sidewalk extension No. 108: JAMES KENNEDY CONSTRUCTION CO., $203,017 (awarded contract); S. Birch & Sons, $214,424; J. W. Mellen, $205,332; Davis & Hueser, $249,335.

Bids are asked until 8 p. m., Oct. 19, by the City Recorder for constructing sidewalks in district No. 10. A. F. Parker is City Engr.

MANUFACTURING PLANTS.

(denotes that this work is advertised in Engineering News.)*

MIDDLETOWN, CONN.—The Russell Mfg. Co. will erect a mill, of brick construction, 110 × 50 ft., at South Farms. One hundred new looms will be installed in the mill as soon as it is completed.

NEW BRITAIN, CONN.—Plans have been completed by the Hart & Cooley Co., of New Britain, manufacturers of steel floor registers and lockers, for a 3-story brick structure, 50 × 57 ft., and a one-story wash room, 16 × 38 ft.

NEW YORK, N. Y.—Bids are asked by Nicholas J. Hayes, Fire Comr., until 10.30 a. m., Oct. 15, for furnishing and delivering iron, steel and various supplies for use at the repair shops.

GLOVERSVILLE, N. Y.—F. L. Comstock, Arch., has completed the plans for the new glove shop of Fownes & Co., of Worcester and London, England, to be erected in this city. The contract for the construction of the building has been let to A. E. GRACE, who has begun the work of excavation for the foundations. The building will be 112 × 44 ft., with two long ells on either side of the rear. It will be four stories high, and will enclose 7,000 sq. ft. on each floor. Noted Sept. 3.

BINGHAMTON, N. Y.—The contract for constructing the cigar factory at Warren and Chenango Sts. has been awarded to M. I. FORD, by P. M. Hummell & Co.

ROCHESTER, N. Y.—The La May Machine Works, 48 North Water St., are to build a plant at the corner of McNaughton and Emerson Sts., comprising a main factory building, a brass foundry and a powerhouse. Later a malleable iron foundry will be erected. The main building will be of brick, 180 × 200 ft., one story with steel truss roof; the founding building, of brick and concrete, 30 × 50 ft.; the power-house, 40 × 60 ft., of brick and concrete.

CANASTOTA, N. Y.—Richard Heim and others of Fabius, N. Y., will erect a 3-story factory here, 60 × 125 ft., of concrete block construction, for the manufacture of various milk products. F. E. STAFFORD, of Earlville, N. Y., has been awarded the contract by Thurber J. Gillette, Arch., 811 Park St., Syracuse. Noted on Sept. 10.

The Milk Products Co. of America has secured a manufacturing site on the Lehigh Valley R. R. here, through its representative, Harry S. Newburger, and it is stated is preparing plans for a plant for the production of butter, casine, etc., and for a cold storage plant with shipping facilities.

ALBANY, N. Y.—The General Knit Fabric Co., of Utica, has been incorporated with the Secretary of State, to make and sell hosiery, underwear, etc. The capital stock is $10,000. The directors for the first year are Robert W. Scott of Leeds Point, N. J.; L. N. D. Williams of Ogontz, Pa., and Joseph L. Marley, of Utica.

TRENTON, N. J.—Articles of incorporation have been filed by the Textile Rubber Co., of this city. The incorporators are: A. W. Ireland, New York; F. E. Sincere, Brooklyn, N. Y., and I. Thatcher, East Orange, N. J. The concern is to do a general waterproofing business, such as waterproofing, spotproofing, spreading of rubber upon and rubberizing silks, woolens, hospital sheeting, fabrics for automobile tops, etc. The capital stock is $50,000.

READING, PA.—Kirk. W. Peuckert has awarded a contract to L. H. Focht, of Reading, for the erection of a beer storehouse here, at $70,000, for the Reading Brewing Co.

PHILADELPHIA, PA.—See item under Buildings.

NORFOLK, VA.—Bids were received as follows on Oct. 3 at the office of the Bureau of Yards and Docks, navy department, Washington, D. C., for the furnishing of laundry equipment for the navy yard at Norfolk: Troy Laundry Machinery Co., 33 Warren St., New York, $3,372; Consolidated Hospital Supply & Laundry Co., Saugautuck, Conn., $4,215; Empire Laundry Machinery Co., Boston, Mass., $3,644; American Laundry Machinery Mfg. Co., 132 West 27th St., New York, $3,495.

GORDONSVILLE, VA.—The Virginia Air Line Ry. Co., Walter Washbaugh, Ch. Engr., Charlottesville, Va., has purchased 18 acres of land at Gordonsville on which to erect a roundhouse, car sheds and other terminal buildings.

LUMBERTON, N. C.—The Dresden Cotton Mills and the Lumberton Cotton Mills of Lumberton, N. C., have decided to jointly build an office structure for the use of their managements. The building will be 30 × 100 ft., two stories, of pressed brick, with all modern conveniences. R. D. Caldwell is Pres. both companies, which operate a total of 28,000 spindles and produce yarns.

HEPHZIBAH, GA.—A company will be incorporated soon to establish a knitting mill at Hephzibah or Augusta, Ga. J. I. Davis and J. J. Tyler, of Hephzibah, are the promoters of the enterprise and are now corresponding relative to the purchase of the necessary machinery. They think of producing hosiery, dyed and finished.

AUGUSTA, GA.—J. Inman Davis, J. J. Tyler and others have made application for a charter for the Gavin Mfg. Co., capital stock $10,000, with privilege of increasing to

$25,000. A factory will be built in Augusta, and the company proposes to manufacture cotton goods, with hosiery as a specialty.

MONTGOMERY, ALA.—The Heyman-Hawthorne Mill Agents Co., has been incorporated in Birmingham, Ala., for a general hosiery and underwear business. Walter Hawthorne is Pres.

ENSLEY, ALA.—See item under Light and Power Plants.

LOUISVILLE, KY.—The New Albany Hosiery Co. has been incorporated with $35,000 capital stock.

STEPHENSBURG, KY.—The Essential Oil Co., of Louisville, Ky., will establish a sassafras plant at Stephensburg.

TOLEDO, OHIO.—The Toledo Electric Vehicle Co. was incorporated on Sept. 25 with a capital of $50,000, the following being the incorporators: Willard E. Allen, A. F. Clark, Frederick B. Willard, E. J. Hall and J. W. Schaufelberger. Willard E. Allen is Pres.

CONNEAUT, OHIO.—The Conneaut Can Co. will erect a new building, 104 × 310 ft., to be used exclusively for the square can department. Work on the new building, which is to be one story high and will contain 26,000 sq. ft. of floor space, was commenced on Sept. 23. by F. T. WALTON, who has secured the contract. It is to be completed by Nov. 1. H. A. Trucsdale is Gen. Mgr.

COSHOCTON, OHIO.—It is reported that construction of the proposed big plant of the James B. Clow Co., Franklin and Harrison Sts., Chicago, at Coshocton, will be commenced soon. It will represent an investment of about $1,000,000. The company manufactures iron pipe and iron pipe supplies.

CLEVELAND, OHIO.—Press reports state that the Upson Nut Co. is planning the erection of a steel plant and bar mill in Cleveland that will cost at least $500,000. A. S. Upson is Pres.

INDIANAPOLIS, IND.—The American Box Ball Co. obtained a building permit on Oct. 3 for the erection of a brick factory building at its plant, corner of Draper and Van Buren Sts. Cost, $5,000.

DETROIT, MICH.—Parker, Webb & Co., 87 Rose St., having acquired a frontage of 542 ft. on Michigan Ave., between 20th St. and Beecher Ave., will begin the erection of a storage and packing plant. The building will have a frontage of 230 ft.

LEAVENWORTH, KAN.—Bids are asked by R. V. La Dow, Supt. of Prisons and Prisoners, Department of Justice, Washington, D. C., until 10 a. m., Oct. 26, for furnishing and delivering at the United States penitentiary, Leavenworth, tanks, coils, ice cans, brine pumps, etc., to be used in extending the ice-making capacity of the refrigerating plant.

CARLYLE, KAN.—The Lumberman's Portland Cement Co., R. A. Long Bldg., Kansas City, Mo., has awarded the contract to VICTOR BEUTNER, Pittsburg, Pa., for the erection of its cement plant at Carlyle. Work on the plant is to begin at once.

OKLAHOMA CITY, OKLA.—The Oklahoma Street Ry. Co. will erect a $60,000 street car barn and shops in Oklahoma City within the next 60 days. The shops and barn will be located on Ollie and Second Sts. and cover twelve acres of land. About $60,000 will be expended on improvements, which will comprise four buildings, a wood-working shop, iron shop, paint shop and street-car barn. John W. Shartel is Gen. Mgr.

VALLEJO, CAL.—The Municipal Brick Co. of San Francisco, has purchased 50 acres of land and is preparing to install a brick-making plant on the bay shore at Glen Cove, between Vallejo and Benicia.

CONTRACT PRICES.

(See also page 129.)

CURBING, ETC.—Salt Lake City, Utah.—Bids were received as follows on Sept. 11 for curb and gutter extension No. 7—(A) J. W. Mellen, Salt Lake City; (B) P. J. Moran, Salt Lake City; (C) S. Birch & Sons Construction Co., Salt Lake City; (D) J. D. HANLEY, Salt Lake City (awarded contract); Louis C. Kelsey is City Engr.:

Abutters' portion:	(A)	(B)	(C)	(D)
2 lin. ft. cement curb, steel reinforced, 6" × 24" and 30" gutter	$1.65	$1.23	$1.50	$2.00
958 lin. ft. cement curb, steel reinforced, 6" × 16" and 30" gutter	1.44	1.13	1.25	1.50
1,963.47 lin. ft. cement curb, steel, reinforced, 6" × 16" curved to special radii	1.18	1.13	.82	.60
838 lin. ft. cement curb, plain, 6" × 24"	1.00	.57	.55	.70
Cement curb, plain, 6" × 24" and 30" gutters	1.57	.96	1.10	1.10
20,035.96 lin. ft. cement curb, plain, 6" × 16" and 30" gutters	1.13	.79	.905	.90
15.71 lin. ft. curved curb for spec. driveways	.94	1.13	.60	.70
168.57 lin. ft. false curb and 14" gutter	.94	.83	1.00	.80
1.7 cu. yds. concrete in special drives	9.44	8.84	7.00	10.00
111.4 lin. ft. reinforced concrete waterways	2.36	1.36	1.00	2.00
4 inlets J. and S. L. G. G. conduit	21.24	12.23	5.00	25.00
2 clean out boxes	21.24	13.56	5.00	16.00
14 brick valve boxes	37.76	40.76	30.00	28.00
11,895 cu. yds. excavation	.65	.87	.68	.60
6,615.64 lin. ft. cement gutter, 30" wide	.56	.56	.478	.60
362.5 lin. ft. furnishing and laying 12" vitrified pipe	.74	.64	.70	1.00
13 storm water outlets	21.24	9.51	15.00	20.00
74 resetting manhole covers	5.90	4.25	5.00	3.00
9 removing trees more than 6" and less than 1 ft. in diameter	4.72	5.50	3.00	3.00
79 removing trees more than 1 ft and over in diameter	8.26	6.80	5.50	5.00
26,400 ft. cost per front ft. of abutting property.	1.592	1.375	1.334	1.324
Total abutters' portion	$42,045	$36,314	$35,240	$34,974
City's portion:	(A)	(B)	(C)	(D)
11,901.13 cu. yds excavation	$0.65	$0.87	$0.68	$0.60
1.43 lin. ft. plain cement curb, 6" × 24"	1.00	.57	.554	.70
15.53 lin. ft. 6" × 16" and 30" gutter	1.13	.87	.955	.95
1.43 lin. ft. false curb and 14" gutter	1.34	.83	1.00	.80
Total city's portion	$7,756	$10,369	$8,110	$7,158
Grand total	$49,801	$46,683	$43,350	$42,131

BARGE CANAL.—Albany, N. Y.—The itemized bids received by F. C. Stevens, Supt. of Public Works, on Oct. 1, for Barge Canal Contract No. 55, which is for constructing a reservoir dam on the Mohawk River; relocating a portion of the Black River Canal; building four locks, and performing all other work appertaining to the contract, are as follows: (A) Engineer's estimate; (B) Coast & Interior Contracting Co., Fayetteville, N. Y.; (C) Dravo Contracting Co. (Booth & Flynn), Lewis Block, Pittsburg, Pa.; (D) Miller Construction Co., Lockhaven, Pa.; (E) MacArthur Bros. Co., 10 Pine St., New York; (F) Stewart-Kerbaugh-Shanley Co., 527 Fifth Ave., New York; (G) Scott Bros., Baldwinsville, N. Y.; (H) Kinser Construction Co., Chicago, Ill.; (I) Gore Engineering & Contracting Co., 260 Broadway, New York; (J) United Engineering & Contracting Co., 32 East 33d St., New York; (K) Linquist & Illsley, 329 North Clark St., Chicago, Ill.; (L) Arthur McMullen, 21 Park Row, New York; (M) Buffalo Dredging Co., Buffalo, N. Y.:

	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)
Clearing (lump sum)	$9,000.00	$9,000.00	$10,700.00	$9,000.00	$10,000.00	$9,000.00	$9,000.00	$9,000.00	$9,000.00	$9,000.00	$9,000.00	$4,500.00	$10,000.00
6,000 cu. yds. grubbing	.40	.40	.40	.40	.45	.40	.40	.40	.40	.40	.40	.40	.40
346,000 cu. yds. excavation	.65	.70	.78	.60	.67	.65	.62	.75	.66	.65	.77	.65	.65
20 M. ft. B. M. sheeting and bracing	60.00	60.00	60.00	60.00	70.00	60.00	55.00	60.00	60.00	60.00	60.00	60.00	60.00
25,200 sq. ft. channeling	.18	.18	.18	.20	.21	.18	.20	.18	.18	.19½	.18	.20	.20
160,600 cu. yds. forming embankment	.15	.15	.15	.15	.18	.15	.17	.15	.15	.15	.15	.18	.16½
440 cu. yds. lining	1.50	1.50	1.50	1.50	1.75	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
820 cu. yds. puddle	1.50	1.50	1.50	1.50	1.80	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
27 M. ft. B. M. sawer lumber	60.00	60.00	60.00	60.00	70.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00	60.00
1,000 lin. ft. round timber bracing	.25	.25	.25	.25	.30	.25	.25	.25	.25	.25	.25	.20	.25
820 lin. ft. foundation piles	.50	.50	.50	.50	.60	.50	.40	.50	.50	.50	.50	.50	.50
19,180 cu. yds. second-class concrete	7.50	7.25	7.90	7.50	6.60	7.50	7.25	8.00	6.50	7.30	7.00	7.00	6.20
927 cu. yds. reinforced concrete	10.00	12.00	10.00	10.00	10.50	10.00	10.00	10.00	8.00	10.00	10.00	10.00	10.00
85,400 cu. yds. Cyclopean masonry	6.25	5.75	6.20	6.50	5.60	5.45	5.95	6.50	5.50	6.19	6.00	5.25	5.50
80 cu. yds. slope wall in mortar	5.00	5.00	5.00	5.00	6.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
80 cu. yds. slope wall, dry	3.50	3.50	3.50	3.50	4.20	3.50	3.60	3.50	3.50	3.50	3.50	3.50	3.50
240 cu. yds. wash wall	2.00	2.25	2.00	2.00	2.40	2.00	2.25	2.00	3.50	2.00	2.00	2.00	2.00
2,520 sq. yds. 24" stone paving	2.50	2.50	2.50	2.50	3.00	2.50	2.51	2.50	2.00	2.50	2.50	2.50	2.50
640 sq. yds. first-class stone paving	2.50	2.50	2.50	2.50	2.75	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
1,400 sq. yds. second-class stone paving	2.00	2.00	2.00	2.00	2.25	2.00	2.00	2.00	2.50	2.00	2.00	2.00	2.00
50 sq. yds. cobblestone paving	1.00	1.20	1.00	1.00	1.20	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
90 cu. yds. first-class riprap	3.00	3.50	3.00	3.00	3.50	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
40 cu. yds. second-class riprap	2.75	3.00	2.75	2.75	3.25	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75
1,180 cu. yds. third-class riprap	2.50	2.50	2.50	2.50	3.00	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
200 cu. yds. fourth-class riprap	2.00	2.25	2.00	2.00	2.40	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
280,000 lbs. cast-iron pipe and specials	.02½	.03	.02½	.02½	.03	.02½	.02½	.02½	.02½	.02⁸/₁₀	.02½	.02½	.02¾
78,280 lbs. structural steel	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05
52,770 lbs. metal reinforcement	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
5,200 lbs. wrought iron	.07	.08	.07	.07	.08	.07	.07	.07	.07	.07	.07	.07	.07
40 lbs. steel castings	.06½	.06½	.06½	.06½	.06½	.06½	.06½	.06½	.06½	.06½	.06½	.06½	.06½
34,000 lbs. iron castings, plain	.04½	.04½	.04½	.04½	.04½	.04½	.04½	.04½	.04½	.04½	.04½	.04½	.04½
81,400 lbs. iron castings, machined	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
920 lbs. bronze castings	.50	.50	.50	.50	.55	.50	.50	.50	.50	.50	.50	.50	.50
5,700 lbs. metal in lock valves	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10
2,300 lin. ft. wooden fence	.22	.25	.22	.22	.20	.22	.22	.22	.22	.22	.22	.22	.25
1,580 lin. ft. wrought-iron pipe railing	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
900 lin. ft. drilling bolt holes in rock	.60	.60	.60	.60	.70	.60	.60	.60	.60	.60	.60	.60	.60
2 capstans	50.00	50.00	50.00	50.00	46.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Superstructure upper gate chamber (lump sum)	2,550.00	2,550.00	2,550.00	2,550.00	2,200.00	2,550.00	2,550.00	2,550.00	2,550.00	2,550.00	2,550.00	2,550.00	2,550.00
Sluice gate apparatus, valves, pipes (lump sum)	8,600.00	8,600.00	8,600.00	8,600.00	7,600.00	8,600.00	8,600.00	8,600.00	8,600.00	8,600.00	8,600.00	8,600.00	8,600.00
Cofferdams, pumping, bailing and draining (lump sum)	19,000.00	19,000.00	19,000.00	19,000.00	15,000.00	19,000.00	19,000.00	19,000.00	19,000.00	22,000.00	19,000.00	4,000.00	20,000.00
Raising and moving highway bridge (lump sum)	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00	150.00
Maintaining highway traffic (lump sum)	650.00	650.00	650.00	650.00	500.00	650.00	650.00	650.00	650.00	650.00	650.00	650.00	650.00
Maintaining navigation (lump sum)	250.00	250.00	250.00	250.00	200.00	250.00	250.00	250.00	250.00	250.00	250.00	250.00	250.00
Deduct price to be paid to the State of New York for bridge superstructures in place, which are to be removed by the Contractor without expense to the State (lump sum)	65.00	65.00	52.00	65.00	75.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00
Deduct price to be paid to the State of New York for buildings in place, which are to be removed by the Contractor without expense to the State (lump sum)	14,725.00	14,725.00	11,780.00	12,000.00	15,000.00	14,725.00	14,725.00	12,000.00	14,725.00	14,725.00	14,725.00	14,725.00	12,500.00
Total	$1,014,525	$989,433	$1,067,533	$1,021,804	$956,421	$946,205	$977,369	$1,082,750	$932,981	$1,099,829	$1,025,145	$905,347	$933,577

MISCELLANEOUS CONTRACTS.

U. S. RECLAMATION SERVICE.—All news relative to canal projects, etc., will be found under Water Supply—Irrigation.

VAULT.—Washington, D. C.—See item under Buildings.

DITCH.—Redwood Falls, Minn.—Bids will be received until Oct. 10 by the County Commissioners for digging and constructing judicial tile ditch No. 4. Estimated cost, $5,165.

RETAINING WALL.—Wheeling, W. Va.—JOHN BOYD, of Wheeling, has been awarded the contract for constructing a retaining wall on Sixth St. at 30 cts. per cu. yd. for excavation and $5 per cu. yd. for stone masonry.

*DREDGING.—Tuckerton, N. J.—Bids are asked by Capt. L. H. Rand, Corps Engrs., U. S. A., Wilmington, Del., for dredging Tuckerton Creek, N. J., until 11 a. m. Oct. 30.

TILE DITCH.—Hartford City, Ind.—Bids will be received until Oct. 17 by the County Commissioners for constructing Ricketts County tile ditch in Harrison Township, 3,795 ft. long.

*LOCK AND DAM.—Mobile, Ala.—Plans are on file at the office of Engineering News, New York, for the improvement of Black Warrior River, Ala., Lock and Dam No. 16. Bids are asked until Nov. 17.

BREAKWATER AND DREDGING.—Rondeau, Ont.—Bids are asked by Nap. Tessier, Secy., Dept. Pub. Wks., Ottawa, Ont., until 4.30 p. m., Oct. 30, for the construction of a breakwater and dredging here.

COAL-SHED.—Fort Ha[illegible] N. Y.—Bids are asked until 11 a. m. [illegible] 30, by the Constructing Quartermast[illegible] S. A., Fort Hamilton, for constructing here (Brooklyn, N. Y. [illegible] shed build. office.)

CEMENT.—New York. [illegible] Y.—Bids are asked by the Park Board [illegible] p. m., Oct. 15, for furnishing and d[illegible] ing 100 barreis Portland cement (No. 2 [illegible]s for parks, Boro. of the Bronx. Henr[illegible]outh is Pres. Bd.

BREAKWATER AND [illegible] GING.—Port Burwell, Ont.—Bids are a[illegible] until 4.30 p. m., Nov. 3, by Nap. Te[illegible] Secy. Dept. Pub. Wks., Ottawa, Ont., [illegible] construction of an extension to the [illegible]kwater and dredging here.

CANAL.—Ottawa, Ont.—Bi[illegible] asked until 4 p. m., Oct. 20, by L. [illegible]ones, Secy. Dept. Railways and Canals, [illegible]ws, for the works connected with the [illegible]truction of Section No. 7, Ontario-Rice [illegible] division of the Trent Canal.

*GYMNASIUM APPARAT[illegible]—Fort Morgan, Ala.—Bids are asked [illegible] 1.30 p. m., Oct. 20, by Lieut. Landerford [illegible]man, Constr. Q. M., for gymnasium appar[illegible] to be properly installed in the gymnasi[illegible] building to be erected at Fort Morgan.

LEVEES.—New Orleans, [illegible]—Bids are asked by the Mississippi Riv[illegible] Commission, Fourth District, 1539 Louisi[illegible] Ave., until Oct. 15 for constructing ab[illegible]461,500 cu. yds. of levee work in Low[illegible] Tensas and Pontchartrain Levee districts.

PIER.—Jersey City, N. J.—The general contract for the construction of a new pier, 66 × 600 ft., at the Jersey City terminal of the Central R. R. Co., is reported to have been awarded to GEO. B. SPEARIN, of Fanwood, N. J., to be completed by Jan. 7, 1909.

SODDING.—Fort Wood, N. Y.—The McHARG-BARTON CO., New York, has been awarded the contract for sodding and repairing terraces at this post (New York, N. Y., post-office), at $2,090. Bids were opened on Oct. 1. William W. Bessell is Constr. Q. M., U. S. A.

STEEL.—Atlanta, Ga.—Bids will be received until Oct. 14 by R. V. La Dow, Supt. of Prisons and Prisoners, Department of Justice, Washington, D. C., for furnishing and delivering at the U. S. Penitentiary, Atlanta, 630 pieces Bessemer steel, 1⅛ ins. in diameter, 11 ft. 6 ins. long.

LEVEE.—East St. Louis, Ill.—The citizens on Sept. 22 voted to construct a levee from Mitchell to a point between East St Louis and Cahokia and an election will be held later for commissioners to have charge of this work, after which an engineer will be appointed. Estimated cost, about $6,500,000.

LEVEE WORK.—New Orleans, La.—Bids will be received until Oct. 15 by Capt. H. Burgess, Corps Engrs., U. S. A., Mississippi River Comm., Fourth District, 1539 Louisiana Ave., New Orleans, for constructing about 461,500 cu. yds. of levee work in the lower Tensas and Pontchartrain Levee districts.

*DREDGING.—Norfolk, Va.—Bids were received as follows on Sept. 30, by Maj. Joseph E. Kuhn, Corps Engrs., U. S. A., for dredging Nansemond River, 20,000 cu. yds.: River & Harbor Improvement Co., Philadelphia, Pa., 29 cts.; L. M. Lewis Dredging Co., Norfolk, Va., 15.4 cts.; Coastwise Dredging Co., Norfolk, Va., 19.4 cts.; Norfolk Dredging Co., Norfolk, Va., 15.5 cts.; Atlantic Dredging Co., Philadelphia, Pa., 23 cts.

FIRE ALARM SUPPLIES.—New York, N. Y.—Bids are asked until 10.30 a. m., Oct. 19, by Nicholas J. Hayes, Fire Comr., for furnishing and delivering supplies for the Fire Alarm Telegraph Bureau, Boro. of Brooklyn, Alarm Telegraph Bureau, Boro. of Manhattan, and for repairishing and delivering supplies and for the Fire Alarm Telegraph Bureau, Boro. of Queens.

*COAL HOISTING TOWER.—San Francisco, Cal.—Bids are asked until 11 a. m., Nov. [illegible], by William S. Cowles, Ch. of Bureau of Equipment, Navy Dept., Washington, D. C., for constructing and erecting a coal hoisting tower upon the wharf trestle at the U. S. Naval Coal Depot, California City Point, Cal.

PIER.—Cleveland, Ohio.—The Great Lakes Dredge & Dock Co., Cleveland, has submitted the lowest bid for the new government pier at the foot of East Ninth St. The bid price is $14,655, which is $14,000 below the sum appropriated by Congress. The contract will be let within the week. The pier is to be completed by June 1 and work will begin at once.

*ROCK EXCAVATION.—Boston, Mass.—Bids were received as follows on Oct. 5 by Lieut.-Col. Edward Burr, Corps Engrs., U. S. A., for 581.5 cu. yds. rock excavation in Beverly Harbor, Mass.: Johnstone & Virden, Del., $11.47 per cu. yd.; Thomas Fitzsimons, Beverly, Mass., $24.85; Eastern Dredging Co., 247 Atlantic Ave., Boston, Mass., $26.80.

DREDGING.—New York, N. Y.—Bids are asked until 11 a. m., Oct. 14, by Bird S. Coler, Pres. Boro. of Brooklyn, for furnishing all the labor and material required for dredging Newtown Creek Canal, at and in the canal and basin included within the boundaries of Johnson Ave., Montrose Ave., Morgan Ave., Varick Ave. and also in the Stagg St. basin, Boro. of Brooklyn, City of New York.

LEVEE WORK.—Marksville, La.—Bids were opened here on Sept. 24 for the improvement of levees and contracts were awarded as follows: Jeansonne's Point Levee, 3,000 cu. yds., C. R. GUILLOT, 12.50 cts.; A. Barbin's Levee, 20,000 cu. yds., LOUIS SAUCIER, 13 cts.; Brouillette's Levee, 8,000 cu. yds., H. J. BROUILLETTE, 12.95 cts. All of this work is in the Parish of Avoyelles, on the right bank of the Red River.

CANAL.—Salt Lake City, Utah.—The State Board of Land Commissioners on Sept. 17 awarded a contract to J. W. HOGGAN, of Manti, for the enlargement of the Sevier Valley Canal, at $42,276. The Western Construction Co., of Richfield, bid $47,037. The canal is owned by the Sevier Valley Canal Co., and will be enlarged so that the water may be carried from the Piute reservoir to a point two miles north of Joseph into state lands. The enlargement will make the canal 40 miles in length.

LEVEES.—New Orleans, La.—Bids were received as follows by the State Board of Engineers on Sept. 24 for the improvement of the levees along Red River: For the new experiment levee on the left bank of Red River, including about 50,000 cu. yds., W. H. Sayes, 18.5 cts. per cu. yd.; I. R. Bobbitt, 19.9 cts.; Francis T. Constant, 17.47 cts.; Charles J. Martin, 17 cts. (recommended to the Governor by the Board for acceptance). Edwards levee, enlargement, about 120,000 yds., R. J. Johnson, 13.75 cts.; Francis T. Constant, 12.18 cts. (recommended for acceptance); C. J. Martin, 15.98 cts.; Robert Coco, 13.94 cts.

*EXCAVATION.—Chicago, Ill.—The following bids were received on Sept. 30 by the Sanitary District of Chicago for excavating a channel designated as Section 5 of the North Shore Channel and for certain collateral bridge work: (a) Section 5; (b) collateral work, Desplaines River Spillway, etc.: Keltie Stone Co., Joliet, Ill., (b) $19,830; James O. Heyworth, Railway Exchange Bldg., Chicago, (a) $40,745, (b) $22,200; J. T. Fanning & Co., Chicago, (a) $48,423, (b) $29,570; John W. Page, Chicago, (a) $48,650; J. J. McCaughey, Chicago, (a) $63,500, (b) $31,455; Rohnheld Construction Co., (b) $22,970. S. J. Bryon is Clk.

BARGE CANAL.—Albany, N. Y.—Twelve bids were received by F. C. Stevens, Supt. Pub. Wks., on Oct. 1, for Barge Canal Contract No. 55, which is for constructing a reservoir dam on the Mohawk River; relocating a portion of the Black River Canal; building four locks, and performing all other work appertaining to the contract; area of reservoir inside of clearing line about 4.8 sq. miles. Engineer's estimate, $1,014,525. The bidders were: Coast & Interior Contracting Co., Fayetteville, N. Y., $989,433; Dravo Contracting Co. (Booth & Flynn), Lewis Block, Pittsburg, Pa., $1,067,533; Miller Construction Co., Lockhaven, Pa., $1,021,804; MacArthur Bros. Co., 10 Pine St., New York, $956,421; Stewart-Kerbaugh-Shanley Co., 527 Fifth Ave., New York, $946,205; Scott Bros., Baldwinsville, N. Y., $977,369; Kinser Construction Co., Railway Exchange, Chicago, Ill., $1,082,750; Gore Engineering & Contracting Co., 260 Broadway, New York, $932,981; Lanquist & Illsley, 329 North Clark St., Chicago, Ill., $1,025,145; Arthur McMullen, 21 Park Row, New York, $905,347; Buffalo Dredging Co., Buffalo, N. Y., $933,577; United Engineering & Contracting Co., 32 East 33d St., New York, $1,000,829. Itemized prices are given in this issue under Contract Prices.

The following bids were received by F. C. Stevens, Supt. of Public Works, on Oct. 1, for Barge Canal Contract No. 61, which is for the improvement of the Erie Canal from the west end of Contract No. 60 to the west line of Monroe County, a distance of 7.39 miles: E. M. Graves, Cleveland, Ohio, $1,047,994; Empire Engineering Corporation, 60 Wall St., New York, $1,092,748. The engineer's estimate is $1,000,219. Frederick Skene is State Engr. and Surv.

CONTRACT PRICES.

(Continued from page 128.)

[Where * precedes item under Contract Prices the work was advertised in Engineering News.]

*FILTERS.—Reading, Pa.—Bids were received as follows on Sept. 22 by the Board of Water Commissioners for building slow sand filters for Maiden Creek water supply: (A) MacArthur Bros.' Co., 11 Pine St., New York, N. Y.; (B) A. G. Vermilye; (C) Bowman Bros.' Co., McKeesport, Pa.; (D) Jos. P. O'Reilly, Reading, Pa.; (E) Clement King Co., Inc., Philadelphia, Pa.; (F) Bunting, Bull Co., Flushing, N. Y.; (G) Robert C. Storrie, Nicetown, Philadelphia, Pa.; (H) Hawman Construction Co., Reading, Pa.; (I) New York Continental Jewell Filtration Co., 15 Broad St., New York, N. Y.; (J) Millard Construction Co., Pennsylvania Bldg., Philadelphia, Pa.; (K) R. A. Malone & Sons, Lancaster, Pa.; (L) David Peoples, Betz Bldg., Philadelphia, Pa.; (M) Gore Engineering & Contracting Co., 206 Broadway, New York, N. Y.; (N) United Ice & Coal Co., Harrisburg, Pa.; (O) S. W. Chiles Reading, Pa.; (P) Shanley-Morrissey Co., Inc., 527 Fifth Ave., New York, N. Y.; (Q) Nolan Bros., Reading, Pa.; (R) Fehr & O'Rourke, Reading, Pa.; (S) L. H. Focht & Son, Reading, Pa.; (T) H. E. AHRENS CO., Reading, Pa.; (awarded contract):

	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)
115,000 cu. yds. excavation	$1.10	$1.14	$0.75	$0.64	$0.80	$0.90	$0.85	$0.57	$0.70½	$0.63
15,000 cu. yds. 1:2:4: concrete	6.25	4.75	7.00	5.95	6.85	5.00	5.10	5.23	4.75	5.50
600 cu. yds. 1:3:6 concrete	6.00	4.00	6.50	6.50	6.85	5.00	5.10	4.14	3.50	4.00
60 cu. yds. brick masonry	7.00	4.00	8.00	8.50	10.00	7.00	10.00	7.50	6.00	6.00
5,050 cu. yds. broken stone&gravel for underdrains	3.00	3.00	2.00	4.00	2.25	2.80	2.50	2.45	2.40	2.45
21,850 cu. yds. placing filter sand	.65	.50	1.00	1.50	.80	.55	.60	.65	.37	.50
200 cu. yds. cinder fill	1.10	2.00	1.00	1.50	1.00	1.00	1.00	.75	.50	.50
1,600 cu. yds. uncoursed rubble masonry	3.00	4.00	4.00	6.00	2.75	3.50	4.00	3.85	3.00	4.00
770 sq. yds. vitrified brick gutters	.55	.75	.50	1.15	.60	.75	.75	.52	.30	.50
6,400 sq. yds. roadway	.85	1.25	1.25	.95	1.15	1.10	1.00	1.30	.58	.80
720 sq. yds. walks	.50	.60	1.00	1.10	.85	1.00	.75	1.25	.30	.45
17,500 sq. yds. sodding	.25	.20	.50	.25	.25	.25	.25	.35	.22	.24
9.5 acres seeding	120.00	15.00	200.00	90.00	50.00	100.00	30.00	60.00	40.00	50.00
2,020 ft. 30″ split vitrified pipe	1.60	1.50	2.00	1.61	1.50	1.30	2.00	1.55	1.50	1.50
345 ft. 21″ vitrified pipe	1.25	.75	1.50	1.51	1.10	1.00	1.50	1.70	.85	1.10
440 ft. 15″ vitrified pipe	.75	.50	1.00	1.30	.45	.80	1.00	1.36	.65	.65
615 ft. 12″ vitrified pipe	.60	.30	.75	1.20	.38	.60	.75	.96	.55	.50
200 ft. 6″ vitrified pipe	.30	.10	.25	.40	.15	.20	.50	.72	.20	.25
35 ft. 4″ vitrified pipe	.25	.06	.25	.30	.10	.20	.50	.52	.15	.25
12,000 ft. 10″ split underdrains	.20	.20	.25	.40	.20	.17	.25	.90	.17	.17
1,220 ft. reinforced concrete conduit	2.50	8.00	5.00	9.50	3.00	6.30	5.00	6.40	4.40	3.75
2-in. vitrified drains for vaulting (lump sum)	1,000.00	250.00	500.00	1,500.00	1,000.00	750.00	500.00	540.00	870.00	300.00
Filter house (lump sum)	15,000	22,000	12,000	14,160	16,500	22,000	20,000	19,160	$17,400	15,900
Total	$296,328	$288,762	$281,472	$280,436	$273,681	$263,815	$257,059	$239,576	$228,329	$224,918

	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)
115,000 cu. yds. excavation	$0.70	$0.61	$0.69	$0.57	$0.55	$0.70	$0.59	$0.59	$0.49	$0.50
15,000 cu. yds. 1:2:4: concrete	5.00	4.00	4.00	5.00	5.00	3.25	4.00	4.10	4.25	4.30
600 cu. yds. 1:3:6 concrete	5.00	3.05	4.00	2.58	4.00	3.25	4.00	4.10	4.15	3.25
60 cu. yds. brick masonry	12.00	5.10	6.00	3.79	10.00	12.00	10.00	5.50	6.00	7.50
5,050 cu. yds. broken stone&gravel for underdrains	1.00	2.50	1.50	2.50	1.35	2.00	2.65	2.15	1.85	1.50
21,850 cu. yds. placing filter sand	.75	.80	.40	.35	.45	.55	.45	.38	.50	.35
200 cu. yds. cinder fill	1.00	1.50	1.00	1.25	1.00	.65	.70	.75	.75	.69
1,600 cu. yds. uncoursed rubble masonry	3.50	5.25	3.00	2.07	4.50	3.50	2.40	2.17	2.60	3.25
770 sq. yds. vitrified brick gutters	.70	.50	.50	.40	.70	.69	.42	.35	.35	.33
6,400 sq. yds. roadway	1.00	1.00	1.15	1.50	.90	.90	.95	.75	.95	.88
720 sq. yds. walks	.50	.75	.75	1.00	.60	.50	.80	.50	.60	.35
17,500 sq. yds. sodding	.40	.25	.25	.28	.20	.15	.22	.25	.22	.22
9.5 acres seeding	50.00	50.00	50.00	100.00	25.00	73.40	60.00	20.00	15.00	40.00
2,020 ft. 30″ split vitrified pipe	1.20	2.00	3.00	1.43	1.25	1.75	1.14	1.29	1.16	1.47
345 ft. 21″ vitrified pipe	.75	1.00	1.50	.86	1.10	1.25	.75	.88	.70	.95
440 ft. 15″ vitrified pipe	.40	.90	.75	.53	.70	.80	.42	.56	.40	.50
615 ft. 12″ vitrified pipe	.30	.60	.50	.39	.35	.65	.30	.46	.30	.38
200 ft. 6″ vitrified pipe	.20	.25	.20	.23	.20	.37	.15	.18	.16	.20
35 ft. 4″ vitrified pipe	.15	.20	.15	.23	.20	.32	.13	.16	.20	.20
12,000 ft. 10″ split underdrains	.30	.40	.40	.28	.30	.33	.21	.21	.20	.20
1,220 ft. reinforced concrete conduit	4.00	4.55	5.00	2.00	5.00	2.10	2.80	2.28	7.30	1.90
2-in. vitrified drains for vaulting (lump sum)	350.00	350.00	500.00	90.28	500.00	.68	225.00	200.00	200.00	350.00
Filter house (lump sum)	11,700	21,000	20,000	22,640	20,000	20,350	16,800	16,720	16,600	21,210
Total	$224,910	$220,264	$215,280	$214,956	$210,513	$201,455	$195,412	$190,663	$188,477	$182,886

*BRIDGE.—Monongahela, Pa.—Bids were received as follows on Sept. 10 by the County Commissioners for the construction of a bridge over the Monongahela River here. The bridge will have two abutments, two stone masonry river piers, three equal truss spans of 450 ft. each, creosoted wooden block floors with two street car tracks, and 6-ft. walk. William Wylie, C. E., Washington, Pa.—(A) King Bridge Co., Cleveland, Ohio; (B) McClintic-Marshall Construction Co., Park Bldg., Pittsburg, Pa.; (C) Fort Pitt Bridge Works, Pittsburg, Pa.; (D) American Bridge Co., 42 Broadway, New York; (E) Pennsylvania Steel Co., Philadelphia, Pa.; (F) Mt. Vernon Bridge Co., Mt. Vernon, Ohio; (G) Penn Bridge Co., Beaver Falls, Pa.; (H) Strobel Steel Construction Co., Chicago, Ill.; (I) Toledo-Massillon Construction Co., Toledo, Ohio:

	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)
2,400 cu. yds. concrete masonry in abutments	$6.75	$7.35	$6.90	$7.00	$7.00	$7.00	$7.00	$7.50	$7.00
20,000 lbs. reinforcing steel rods	.03	.03	.02	.03	.02	.02	.03	.03¼	.03
3,260 cu. yds. stone masonry in river piers	8.75	9.45	8.75	9.00	9.00	9.00	9.00	9.75	9.00
320 hard wood piles in river piers	14.50	15.75	10.50	15.00	12.00	15.00	15.00	16.00	15.00
3,700 cu. yds. grading in approaches	.95	1.05	.45	1.00	.80	1.00	1.00	1.10	1.00
1,100 sq. yds. brick paving approaches	2.00	2.10	2.00	2.00	2.00	2.00	2.00	2.25	2.00
40 lin. ft. sandstone curbing	.80	1.05	.80	1.00	1.00	1.00	1.00	1.10	1.00
200 cu. yds. broken limestone on approachs	2.00	2.10	2.00	2.00	2.00	2.00	2.00	2.25	2.00
1,850 tons substructural steel	56,112	60,744	53,142	57,880	55,980	57,680	57,880	62,594	57,880
Superstructure, with floor	178,000	175,670	163,900	240,120	192,800	189,350	189,465	210,000	188,450
Bridge complete	$234,112	$236,414	$217,042	$298,000	$248,780	$247,030	$247,345	$272,594	$246,330

U. S. POSSESSIONS AND CUBA.

ENGINEERING SUPPLIES. — Panama. — Bids are asked by Capt. F. C. Boggs, Corps Engrs., U. S. A., Gen. Purchasing Officer, Isthmian Canal Comn., Washington, D. C., until 10.30, Oct. 26, for furnishing engineering and electrical supplies.

RAILWAY SUPPLIES, TOOLS.—Panama.—Bids are asked until 10.30 a. m., Oct. 22, by Capt. F. C. Boggs, Corps Engrs., U. S. A., Gen. Purchasing Officer, Isthmian Canal Comn., Washington, D. C., for furnishing railway supplies, tools, etc.

CRANES.—Panama.—The Isthmian Canal Commission has issued an amendment to the proposals for furnishing four berm and four chamber cranes (Circular No. 467), postponing the date of opening of these bids from Oct. 7 to 10.30 a. m., Oct. 17.

BRIDGE.—Cuba.—CHAMPION & PASCUAL, of Havana, have secured a contract for the erection of a steel bridge across the Almendares River, Havana, Cuba. Plans for the bridge call for the erection of a concrete structure, reinforced by steel, 750 ft. long and 45 ft. wide. The bid was for $179,823 and under the contract the structure must be completed by June 1.

LUMBER.—Panama.—Bids were received as follows Oct. 6 at the office of the Isthmian Canal Commission, Washington, for the furnishing of (1) 2,150,000 ft. B. M. lumber, yellow pine or Douglas fir, and (2) 2,076 untreated piles, various lengths: A. S. Bacon & Sons, Savannah, Ga (1) $55,900; (2) $19,461. American Tie & Timber Co., New York, (2) $19,518. Bay Shore Lumber Co., Mobile, Ala., (1) $49,987. Carter Lumber Co., Houston, Tex., (1) $59,250. G. Elias & Co., Buffalo, N. Y. (pine) (1) $51,600; (2) $19,708; (fir) (2) $48,575. William D. Gill & Sons, Baltimore, (1) $53,535. J. K. Joice, Kansas City, Mo., (1) $64,800. E. H. Lewis Lumber Co., Seattle, Wash., (1) $50,525; (2) $25,620. Sabine Lumber Co., Kansas City, Mo., (1) $53,900; (2) $24,525. Southern Sawmill Co., New Orleans, La., (1) $52,875. Salmen Brick & Lumber Co., New Orleans, (1) $58,775; (2) $25,620. Cheatham & Co., Seattle, Wash., (2) $25,932. Chicago Lumber & Coal Co., St. Louis, (1) $46,925. Arthur Gamwell, Seattle, Wash., (1) $47,730; (2) $24,044. D. L. Gillespie & Co., Pittsburg, (1) $45,050; (2) $19,708. Robert R. Sizer & Co., Seattle, Wash., (1) $48,912. W. R. Grace & Co., San Francisco, Cal. (1) $46,010; (2) $27,197.

FOREIGN CONTRACTS.

(To insure prompt attention, letters upon consular business should be addressed to the American Consul at ———, ———. Such letters are opened and attended to by the person that may be in charge of the office. If addressed to the consul, personally, letters are forwarded to him, unopened, should he be absent, and a delay thus intervenes. If, in the meantime, he should have gone out of office, the matter may wholly escape attention.)

RAILWAY.—Spain.—Don Manuel Vegas y Martinez has applied to the Dirección General de Obras Públicas, Madrid, for a concession for the construction of a railway from Chillón, on the Madrid-Badajoz Ry., to Logrosán.

CABLE INSTRUMENTS.—Australia.—Bids are asked by Capt. Collins, Commonwealth Representative, 72 Victoria St., Westminster, London, S. W., until noon, Oct. 19, for four complete sets of instruments (signalling and protecting) necessary for direct duplex cable working.

MINES.—Turkey.—Bids are asked until Nov. 26 by the Minister of Forests, Mines and Agriculture, Constantinople, for a 99-year concession for a silver-lead and zinc mine at the village of Kemur Dur in the Sidikeui Commune of the Aidian Vilayet (Smyrna District).

WIRELESS TELEGRAPH. — Australia. — Bids are asked until Dec. 9, by the Secy., Postmaster-General's Dept., 51 Spring St., Melbourne, for the supply and erection of installations for wireless telegraphy at Launceston, Melbourne, King Island (Bass Straits) and Flinders Island.

RAILWAY.—Belgium.—Bids are asked by the Société Nationale des Chemins de Fer Vicinaux, Rue de la Science 14, Brussels, at 11 a .m., Oct. 2, for the construction of the Spa-Sart section of the local railway from Spa to Verviers. The estimated cost of the work is about $8,500.

PUBLIC WORKS.—Russia.—The municipality of Windau is contemplating improvements, such as water-works, tramways, canalization, and modern street lighting, as well as the arrangements necessary to constitute Windau a modern bathing place. The Crown has granted powers to borrow about $500,000 for the purpose, this loan to be without any guarantee on the part of the Government.

RAILWAY.—Netherlands.—A project has been drawn up for the improvement of the means of communication in the east of the province of Groningen by means of steam tramways. The scheme comprises the following lines: (1) Winschoten-Blijham and Bellingwolde; (2) Blijham-Winschoten-Vlagtvedde-Wollinghuizen-Sellingen and Ter Apel; (3) Winschoten - Scheemda - Midwolda-Woldendorp - Termunten - Termuntersijl - Oterdum-Heveskes-Weiwerd-Farnsum and Delfzijl, of the respective lengths of 13,650 meters, 33,200 meters and 35,990 meters, a total of 82,840 meters. The estimated cost is 2,170,000 florins (about $850,000), which includes the cost of the rolling stock. The rolling stock is to consist of twelve locomotives, twelve passenger cars, six closed freight cars with postal compartments, eight closed freight cars, twelve cars for cattle transport, twelve open freight cars, and ten cars for transport of straw.

The Yzendijksche Tramway Maatschappij proposes to construct and work a tramway from Philippine through Hoek and Terneuzen to Zaamslag, in connection with a line in the direction of Zzendijk, to join the Hontenisse Selzaete line at Zaamslag.

CIVIL SERVICE EXAMINATIONS.

CLERK.—New York, N. Y.—Applications will be received until 4 p. m., Oct. 10, for the position of clerk (male), second grade, Board of Water Supply. (No application received by the Commission, by mail or otherwise, after 4 p. m., Oct. 10, will be accepted.) The examination will be held on Nov. 6, at 10 a. m.

EXAMINER MECHANICAL APPLIANCES, ETC.—Washington, D. C.—An examination will be held by the U. S. Civil Service Commission on Oct. 28, to secure eligibles from which to make certification to fill a vacancy in the position of examiner of textiles and mechanical appliances, in the Bureau of Engraving and Printing, at $1,400 a year, and vacancies requiring similar qualifications as they may occur. Age limit, 20 years. Application Form 1093.

LABORATORY AID.—Washington, D. C.—The U. S. Civil Service Commission announces an examination on Oct. 28 to secure eligibles from which to make certification to fill a vacancy in the position of laboratory aid (male), qualified in horticulture, in the Bureau of Plant Industry, at $40 a month, a vacancy in the position of laboratory aid in seed testing (female), in that bureau, at a salary of $600 to $720 a year, and vacancies requiring similar qualifications as they may occur in the Department of Agriculture. Men only will be admitted to the examination for laboratory aid qualified in horticulture, and women only to the examination for laboratory aid in seed testing. Age limit, 17 to 25 years. Application Form 304.

INDUSTRIAL NOTES.

THE BUCYRUS CO., of South Milwaukee, Wis., manufacturers of dredging machinery, etc., advises us that it has established an office in New York at 50 Church St. H. P. Eells is Pres.

THE ENGINEERING SERVICE CO. (Inc.), electrical engineers and purchasing representatives, 90 West St., New York, announce that it has established offices in the West St. Bldg. for the transaction of a general electrical engineering and contracting business, in the equipment of industrial power and other plants. Gerard B. Werner, E. E., is Pres.; Robert Josephi, E. E., Secy. and Treas.

GEORGE W. JACKSON, INCORPORATED, Chicago, announces that a special steamer trip will be made to show some of the firm's work to representative business men of Chicago. The points visited will include (1) the disposal station on the Chicago River (for delivering refuse, excavated material, etc., from tunnel cars to self-propelling dump scows); (2) the deep foundations and subbasements of the Steele-Wedeles Building; (3) the aerial tramway for handling material between the shore and the lake shafts of the 73d St. water tunnel; (4) the bridge and steel shops of the firm; and (5) the Blue Island Ave. tunnel.

THE LINK-BELT CO., of Nicetown, Philadelphia, Pa., writes us that they have work under way for the following orders: Cuba—Sugar conveyors and elevators, three contracts. Delaware—Elevating and conveying machinery for soda. Florida—Phosphate rock and miscellaneous machinery at four different locations. Pennsylvania—Conveyors and elevators for fuel-testing plant, apron conveyor at coke plant, car haul at coal mine, coal crushing machinery for coal and coke company, coal pocket for retail yard, large "Monobar" conveyor at coal mine. New York—Locomotive coaling stations, belt conveyor, retail coal pockets, conveyor for wood refuse. Ohio—Coal pocket machinery. West Virginia—Car hauls and coal chutes.

THE AMERICAN BLOWER CO., Detroit, Mich., has sent us the following list of contracts which are among those awarded the company since Sept. 1: Forced draft equipment, Ault & Wiborg, Cincinnati, Ohio; forced draft equipment, Hocking Valley R. R., South Shops, Columbus, Ohio; forced draft equipment, W. W. Rice Leather Co., Petoskey, Mich.; salt dryer, Worcester Salt Co., Ecorse, Mich.; round-house heating, Northern Pacific R. R., Paradise, Mont.; brick dryer, Berling Heights (Ohio) Brick & Tile Co.; forced draft equipment, Empress Hotel, Victoria, B. C.; round-house heating equipment, N. Y. C. & H. R. R. R., Avis, Pa.; heating and ventilating apparatus, Western State Normal School, Kalamazoo, Mich.; electric light plant, G. Roene, Douglas, Alaska; soap dryer, Summit City Soap Co., Ft. Wayne, Ind.; forced draft equipment, White Haven (Pa.) Sanitarium; heating and ventilating paper mill, four sets of apparatus, Anglo-Newfoundland Development Co., Grand Falls, Newfoundland; heating and ventilating, apparatus, M. E. Church, Philadelphia, Pa.; heating and ventilating apparatus, Philips (Wis.) School; forced draft equipment, Medford (Mass.) Insane Asylum; heating and ventilating equipment, Eastern Michigan Asylum, Pontiac, Mich.; heating and ventilating apparatus, Abington (Pa.) School; heating and ventilating apparatus, Crystal Springs Bleachery Co., Chickamauga, Ga.; heating and ventilating apparatus, High School, Sistersville, Ga.; forced draft apparatus, Gluck Realty Co., Niagara Falls, N. Y.; ventilating apparatus, Carnegie Science Hall, Wittenberg College, Springfield, Ohio; forced draft apparatus, Central Union Gas Co.; heating and ventilating apparatus, Ford City (Pa.) High School; heating and ventilating equipment, Celluloid Co., Newark, N. J. (Evans-Admirall Co., Contractors); heating and ventilating apparatus, Dollar Savings Bank, Youngstown, Ohio; ventilating apparatus, La Porte (Ind.) County Jail; ventilating apparatus, Tucson High School; ship ventilation and induced draft, Collingwood (Ont.) Shipbuilding Co.; heating and ventilating apparatus, Mahoning County Court-House, Youngstown, Ohio; heating and ventilating apparatus, State Homeopathic Hospital for the Insane, Allentown, Pa.; special gas exhauster, Lincoln (Neb.) Gas & Electric Light Co.; ventilating apparatus, First Baptist Church, Dallas, Tex.; moist air dry kiln, Flint (Mich.) Body Co.; forced draft apparatus, Garfield (Utah) Smelting Co.

THE CENTRAL STATES WATER-WORKS ASSOCIATION held its twelfth annual convention at Pittsburg, Pa., Sept. 15-17, with John Langan, of Tipton, Ind., as presiding officer. The following were among the exhibitors:

Galuber Brass Mfg Co., Cleveland, Ohio.—Line of water-works brass goods, guaranteed for five years.

Pittsburg Meter Co., T. C. Clifford, Gen. Agt., Pittsburg, Pa.—Keystone and Eureka meters.

Pittsburg Filter Mfg. Co., F. B. Leopold, Gen. Mgr., Erie W. Bacharacha, Pittsburg, Pa.—Showing photographs of construction of filter plants at Loraine, Harrisburg and elsewhere.

East Jersey Pipe Co., E. E. Menter, Chas. L. Parmelee, Ch. Engr., New York—Exhibiting sections of lock-bar steel pipe before and after making joint; also photographs showing interior surface of riveted as compared with lock-bar joints, proving less frictional resistance in favor of the lock-bar pipe. Also catalog, and as souvenirs, nickel-plated sections of lock-bar joint.

National Meter Co., George H. Bailey, Jr., Mgr., Glen C. Smith, Pittsburg; Alba L. Holmes, Grand Rapids, Mich.—Displaying Crown Empire, Nash, Gem and Premier meters. Also represented by W. E. Cox, Cincinnati.

Hersey Mfg. Co., A. H. McAlpine, E. F. Mull, Columbus, Ohio; L. S. Barnard, Buffalo, N. Y.—Disc, rotary, torrent and detector meters.

Rensselaer Mfg. Co., Troy, N. Y.—George M. Keefer, Pittsburg, Agent.

Fairbanks Co., Wallace McCausland, Pittsburg; John F. O'Brien, New York—Standard iron body double-gate valves and underwriters' hydrant, showing special control valve.

American Valve & Meter Co., D. T. Fenner, Cincinnati—Acorn water meters.

Union Water Meter Co., Leslie P. Anderson, Worcester, Mass.

Harris Pump & Supply Co., Pittsburg, Pa.

Rust Boiler Co., Pittsburg, Pa.—Catalogs giving reports of tests on rust water tube boiler model of Rust patent pressed tube sheet, a novel feature of this boiler.

National Water Main Cleaning Co., Daniel H. Buell, New York City—showing sections of pipe nearly closed by incrustations and sediment, interesting catalogs explaining process, etc.

Neptune Meter Co., New York—Trident meters.

Ford Meter Box Co., Hartford City, Ind.—Displaying its meter box, etc.

Builders' iron foundry, Providence, R. I.

Lead Lined Iron Pipe Co., P. J. Kelly, Wakefield, Mass.—Lead lined iron pipe and tin lined iron pipe and fittings, such as elbows, stop-cocks and valves.

Thomson Meter Co., J. C. Beardsley, Cleveland, Ohio—Lambert meters, and bulletin showing result of test between 4" Empire meters and 4-in. Lambert meters, which displaced the former at Cleveland, Ohio.

Meter Record Co., Cleveland, Ohio—Aluminum record files.

Hays Mfg. Co., Erie, Pa.—McNamara hydrants and street washers; also extension service boxes.

Water-Works Equipment Co., New York City.

Addressograph Co., Chicago, E. J. Hammersley, Mgr., Pittsburg office.

An account of the convention may be found on Page 350, issue of Sept. 24.

TRADE PUBLICATIONS.

BLOW TORCHES.—Walter Macleod & Co., 213 East Pearl St., Cincinnati, Ohio. Catalog No. 100. Paper; 4 × 8¾ ins.; pp. 48; illustrated.

This catalog contains descriptions of the methods and results of the use of Buckeye oil heaters in a variety of different forms. Whitewashing and painting machines, sand blast machines, acetylene outfits and electric drills and grinders are also shown.

DRAWING AND SURVEYING INSTRUMENTS.—F. Weber & Co., 1125 Chestnut St., Philadelphia, Pa. Paper; 6 × 9 ins.; pp. 280; illustrated.

A complete line of drawing materials and surveying instruments is listed in this catalog.

SPRING-SEAT VALVES.—Crosby Steam Gage & Valve Co., 16 Dey St., New York. Paper; 4 × 8¾ ins.; pp. 5; illustrated.

Sectional views and a brief description of Crosby spring-seat valves are contained in this booklet.

CONTRACTORS' LOCOMOTIVES.—Vulcan Iron Works, Wilkes-Barre, Pa. A number of pamphlets. Paper; 6 × 9 ins.; illustrated.

These pamphlets contain tables of general dimensions, weights, tractive force and hauling capacities on various grades of several types of contractors, logging and plantation locomotives.

CENTRIFUGAL PUMPS.—United Iron Works, Second and Jefferson Sts., Oakland, Cal. Folder 28. Paper; 6 × 9 ins.; pp. 30; illustrated.

Eclipse centrifugal pumps are made both with horizontal and vertical shafts for a great variety of uses. Tables of general dimensions, specifications and prices are included in this folder.

ORE CONCENTRATION. — National Ore Concentration Co., Chicago, Ill. Bulletin No. 5. Paper; 7¾ × 10¾ ins.; pp. 19; illustrated.

The Woodbury system of concentration is explained in this bulletin. Illustrations and general specifications of Woodbury slime classifiers and jigs are shown.

SUCTION CONVEYORS.—Darley Engineering Co., 80 Broadway, New York. Bulletin No. 1. Paper; 8 × 10 ins.; pp. 16; illustrated.

The suction conveyor system and its operation is described and discussed in this bulletin with special reference to its use as an ash conveyor.

OIL FILTERS.—Standard Gage Mfg. Co., Syracuse, N. Y. Bulletin No. 1. Paper; 8 × 11 ins.; pp. 28; illustrated.

In this bulletin are described Eclipse filters, oiling systems and exhaust heads. Principal dimensions and list prices are tabulated.

ELECTRIC-MOTOR DRIVES.—Fort Wayne Electric Works, Fort Wayne, Ind. Bulletin 1111. Paper; 8 × 10½ ins.; pp. 24; illustrated.

This bulletin is composed mostly of halftones showing the various applications of electric motors to driving machinery directly. There is a little general description matter on motor-drive systems and on the various types of motors employed.

GASOLINE HOISTS.—The Foos Gas Engine Co., Springfield, Ohio. Circular 77. Paper; 9 × 7 ins.; pp. 8; illustrated.

The details of construction of this concern's line of hoists are set forth herein.

ELECTRIC MANUFACTURE OF STEEL.—Societe Anonyme Electrometallurgique, Procedes Paul Girod, C. W. Leavitt & Co., 220 Broadway, New York City, American Selling Agents. Paper; 5 × 8½ ins.; pp. 20; illustrated.

A description of the Girod furnaces and particulars of this process of producing high grade steels are given.

STEAM POWER.—Harrison Safety Boiler Works, Philadelphia, Pa. Paper; 7 × 10 ins.; pp. 12; illustrated.

This pamphlet is a reprint of an article by Mr. G. H. Gibson, in the "Bookkeeper" on the utilization of heat from exhaust steam.

MERCURY-VAPOR LAMPS.—Cooper Hewitt Electric Co., 220 West 29th St., New York City. Bulletins 19, 20 and 21. Paper; 7 × 10 ins.; total pp. 20; illustrated.

These three bulletins describe the well-known Cooper Hewitt lamp as made in four types; direct-current hand, and automatic, tilting, direct and alternating-current automatic nontilting.

NERNST LAMPS.—Nernst Lamp Co., Pittsburg, Pa. Bulletin A. Paper; 4½ × 6 ins.; pp. 30; illustrated.

A general description of the advantages of the Nernst lamp is illustrated with pictures of artistic fixtures especially adapted to these lamps.

STEEL FOR ELECTRICAL TRANSFORMERS.—General Electric Co., Schenectady, N. Y. Publication No. 3687. Paper; 5 × 7½ ins.; pp. 8; illustrated.

The history of steel for the laminated cores of transformers is briefly treated as an introduction to the manufacture of silicon steel, the popular product for such work.

SEWING MACHINE MOTORS.—General Electric Co., Schenectady, N. Y. Bulletin 4611. Paper; 8 × 10½ ins.; pp. 8; illustrated.

These motors are adapted to domestic use and for light manufacturing purposes. Those intended for domestic use are provided with a jaw clamp foot, enabling the motor to be readily attached to the sewing machine table, and are arranged for use with all standard makes of machines. Motors for all of these purposes are made for use on 115 and 230-volt direct-current circuits, and 110 and 220-volt, 60-cycle alternating-current circuits, in sizes of 1/30, 1/15, 1/10, 1/8, 1/6 HP. The bulletin gives dimensions, weights, etc.

ELECTRICITY MEASURING INSTRUMENTS.—General Electric Co., Schenectady, N. Y. Bulletin 4615. Paper; pp. 4; illustrated.

Bulletin 4612 describes an automobile instrument consisting of a combination ammeter and voltmeter enclosed in a dust-proof and moisture-proof aluminum case, and is designed to withstand the constant vibration and exposure incident to service on electric vehicles. The two scales of this instrument are so arranged that they may be read simultaneously.

Bulletin 4615 describes a portable standard test meter for checking service meters in place.

A novel instrument, which screws into an ordinary Edison socket and holds in the other end an incandescent lamp and indicates the watts taken by the lamp, is described in Bulletin 4609.

Bulletins 4601 and 4602 describe and illustrate automatic voltage regulators for alternating and direct-current generators.

SUCTION GAS PRODUCER.—Weber Gas Engine Co., Kansas City, Mo. Brochure 60. Paper; 4 × 9 ins.; pp. 4; illustrated.

A "down-draft" suction gas producer for bituminous coals, peat and lignite is described in this folder. Results of nine tests are given in a table showing analysis and heating value of fuel, analysis of gas made and fuel used per B. HP. developed. No clue is given as to the conditions of the tests.

MACHINE TOOLS.—Gisholt Machine Co., Madison, Wis. Paper; [illegible] 6 ins.; pp. 72; illustrated.

This booklet shows in co[illegible] form the entire line of machine tool[illegible] manufactured by this company.

ANTI-FRICTION METAL.—[illegible]ier Metal Co., 116 Broad St., New [illegible]rk. Paper; 6 × 9 ins.; pp. 20; illust[illegible]

The properties of Glacier [illegible]al are described, and particulars are [illegible]n in tabulated form of friction, compre[illegible]n and temperature tests which have [illegible] made on this metal.

TURBINE PUMPS.—Dayton [illegible]raulic Machinery Co. Dayton, Ohio. Bulletin No. 81. Paper; 6 × 9 ins.; pp. [illegible] illustrated.

In addition to descriptions, [illegible]ecifications and prices of Dayton turbine [illegible]mps, this bulletin contains several by[illegible]ble tables useful to pump users. Dayton pumps are made for belt drive and for dir[illegible] connection to electric motors and steam [illegible]rbines.

CONTRACTORS' MACHINERY AND SUPPLIES.—W. M. Pattison Supply Co., Cleveland, Ohio. Special cat[illegible]g. Paper; 6 × 9 ins.; pp. 276; illustrat[illegible]

In this catalog, net prices are given in all cases. A complete index adds to the convenience of reference. Machinery may be rented from this company by contractors who prefer such an arrangement.

REINFORCED CONCRETE. — Expanded Metal & Corrugated Bar Co., Frisco Bldg. St. Louis, Mo. "Designing Methods-Reinforced-Concrete Construction," Vol. I., No. 4, August, 1908. 5½ × 9 ins.

This number of the current volume of the bulletin, which we have noted in these columns before, is entitled "Standard Designs for Bridges and Culverts for Highway Traffic—Flat Slab and Girder Type."

WOOD PRESERVATIVE.—Carbolineum Wood Preserving Co., 349 West Broadway, New York, N. Y. Bulletin 30. Paper; 6 × 9 ins.; pp. 16; illustrated.

An article on the open-tank treatment with special reference to the natural vacuum method is reproduced in this bulletin. The illustrations show actual plants installed for treating ties, paving blocks, etc., with carbolineum.

STEEL MINE TIMBERS.—Carnegie Steel Co., Pittsburg, Pa. Pp. 29; 10 × 8¼ ins.; illustrated.

The Carnegie Co. for many years has been experimenting with structural steel to supplant timber in mine props and supports, and it has now what it considers an efficient and economical system. In view of the probable future lack of timber the plans as set forth in the catalog are well worth the attention of all mining engineers and superintendents.

BOILER-DRAFT REGULATION.—Lathrop Engineering Co., 115 Liberty St., New York City. Paper; 4 × 8 ins.; pp. 16; illustrated.

This pamphlet describes the so-called "equalized draft" system for burning coal in power plants. A turbine-driven fan at each boiler creates a pressure in the ash pit sufficient to give the desired combustion. The speed of the fan and the air pressure under the grates is controlled by the steam pressure. The flue dampers are adjusted so that they just carry off the waste gases when the firing doors are open, but do not allow a draft through these doors.

BUSINESS SYSTEMS.—W. H. Chamberlin & Co., 150 Nassau St., New York. Paper; 7 × 10 ins.; pp. 40; illustrated.

This booklet shows reproductions of specimen cards for a great variety of card index systems covering all classes of business records and briefly explains the method of indexing corresponding to each card. Card index and filing cabinets are described and shown by illustrations. In an accompanying folder, the "Dick" steel safe-cabinet is described as a convenient and fireproof repository for papers, documents, etc.

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